# MINERAL STATUS OF SOILS AND FORAGES IN CENTRAL FLORIDA AND EFFECT OF SUPPLEMENTAL DIETARY PHOSPHORUS ON PERFORMANCE OF GRAZING CATTLE

BY

J. EDMUNDO ESPINOZA

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL OF
THE UNIVERSITY OF FLORIDA
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1990

UNIVERSITY OF FLORIDA LIBRARIES

ACKNOWLEDGEMENTS

I wish to express my sincere gratitude and appreciation to Dr. Lee R. McDowell, adviser and chairman of my supervisory committee, for his valuable guidance and assistance throughout the investigation and preparation of the present dissertation. Acknowledgments are also due to Drs. Joseph H. Conrad, Clarence B. Ammerman, Charles R. Staples and O. Charles Ruelke for their time and advice as members of the supervisory committee.

Recognition and appreciation are due to Mrs. Nancy Wilkinson for her assistance in all laboratory work and to Dr. Frank G. Martin and Linda Tang for their assistance in statistical analysis.

Special appreciation is due to the owners of the Deseret Ranches of Florida who offered their land and animals and through their personnel assisted in the conduction of the experiment. A especial thanks goes to Mr. Paul Genho, Mr. Gene Crosby and Mr. Leonard Story for making this experiment possible.

Special thanks go to Instituto Boliviano the Tecnologia Agropecuaria and Organization of American States for the financial support for two years of my studies in the United States. Additional time on assistantship and research cost

were supported in part by the U.S. Department of Agriculture managed by the Caribbean Advisory Group (CBAG).

Deep appreciation goes to Roger, Oswaldo, Akhmad, Rodrigo, Alfonzo, Diana, Libardo, Scott, Larry, Pablo, and all other graduate students who assisted me in sample collection, preparation and analyses.

Finally, the author wishes to give especial recognition to his parents, sons, brothers, wife and friends.

TABLE OF CONTENTS

PAGE

ACKNOWLEDGMENTS . . . . . ii

LIST OF TABLES . . . . . vii

LIST OF FIGURES . . . . . x

ABSTRACT . . . . . xi

CHAPTERS

I INTRODUCTION . . . . . 1

II LITERATURE REVIEW . . . . . 4

The Role of Phosphorus in Animal Nutrition . . . . 4
Functions . . . . . 4
Absorption . . . . . 6
Endogenous Losses . . . . . 8
Requirements . . . . . 11
Deficiency . . . . . 16
Supplementation . . . . . 19
Assessment of Mineral Status in Ruminants . . . . 21
Blood Serum Minerals . . . . . 23
Calcium and phosphorus . . . . . 23
Magnesium . . . . . 24
Zinc . . . . . 26
Copper . . . . . 27
Selenium . . . . . 28
Liver Minerals . . . . . 29
Iron . . . . . 30
Copper . . . . . 31
Manganese . . . . . 32
Cobalt . . . . . 33
Molybdenum . . . . . 34
Zinc . . . . . 35
Selenium . . . . . 36
Bone Minerals . . . . . 37
Calcium and phosphorus . . . . . 37
Magnesium . . . . . 39
Hair Selenium . . . . . 39

PAGE

Mineral Status of Soils and Plants . . . . . 40
Macrominerals . . . . . 41
Trace Minerals. . . . . 43

III MATERIALS AND METHODS. . . . . 47

Description of the Experiment. . . . . 47
Sample Collection . . . . . 53
Soil Samples. . . . . 53
Forage Samples. . . . . 54
Animal Tissue Samples . . . . . 55
Liver biopsy . . . . . 55
Bone biopsy . . . . . 56
Blood samples. . . . . 56
Hair samples . . . . . 57
Mineral Supplement samples . . . . . 57
Sample preparation and Chemical Analysis.. . . . . 57
Animal Tissue Samples . . . . . 58
Forage Samples . . . . . 60
Soil Samples . . . . . 61
Mineral Supplement Samples. . . . . 62
Statistical Analysis . . . . . 62

IV EFFECT OF DIETARY PHOSPHORUS LEVEL ON PERFORMANCE AND MINERAL STATUS OF GRAZING CATTLE IN CENTRAL FLORIDA . . . . . 65

Introduction . . . . . 65
Materials and Methods. . . . . 66
Results and Discussion . . . . . 70
Fertility . . . . . 70
Body Weight . . . . . 72
Cow Serum Analyses . . . . . 74
Calf Serum Analyses . . . . . 80
Serum Minerals of Open vs Pregnant Cows . . . 83
Liver Mineral Concentrations. . . . . 85
Bone Minerals . . . . . 87
Hair Selenium . . . . . 89
Relationship of Minerals. . . . . 89
Summary . . . . . 91

V FORAGE AND SOIL MINERAL CONCENTRATIONS OVER A THREE YEAR PERIOD IN CENTRAL FLORIDA
I. MACROMINERALS . . . . . 93

Introduction . . . . . 93
Experimental Procedure . . . . . 94
Results and Discussion . . . . . 96

PAGE

Soils . . . . . 96
Forage . . . . . 99

Summary . . . . . 104

VI FORAGE AND SOIL MINERAL CONCENTRATIONS OVER A THREE YEAR PERIOD IN CENTRAL FLORIDA
I. MACROMINERALS . . . . . 106

Introduction . . . . . 106
Experimental Procedure . . . . . 107
Results and Discussion . . . . . 109
Soils . . . . . 109
Forage . . . . . 111
Summary . . . . . 115

VII MONTHLY VARIATION OF FORAGE AND SOIL MINERALS IN CENTRAL FLORIDA I. MACROMINERALS . . . . . 117

Introduction . . . . . 117
Experimental Procedure . . . . . 118
Results and Discussion . . . . . 120
Soils . . . . . 120
Forage . . . . . 124
Relationship of Minerals. . . . . 129
Summary . . . . . 129

VIII MONTHLY VARIATION OF FORAGE AND SOIL MINERALS IN CENTRAL FLORIDA II. TRACE MINERALS . . . . . 131

Introduction . . . . . 131
Experimental Procedure . . . . . 132
Results and Discussion . . . . . 134
Soils . . . . . 134
Forage . . . . . 137
Relationship of Minerals. . . . . 142
Summary . . . . . 143

IX SUMMARY AND CONCLUSIONS. . . . . 144

APPENDIX A SUPPLEMENTARY TABLES . . . . . 152

APPENDIX B FIGURES . . . . . 165

APPENDIX C RAW DATA. . . . . 171

LITERATURE CITED. . . . . 244

BIOGRAPHICAL SKETCH . . . . . 261

LIST OF TABLES


| Table | | Page |
|---|---|---|
| 1. | COMPOSITION OF THE MINERAL MIX FED DURING THE FIRST YEAR OF THE EXPERIMENT | 48 |
| 2. | COMPOSITION OF THE MINERAL MIX FED DURING THE SECOND AND THIRD YEARS OF THE EXPERIMENT | 49 |
| 3. | PHOSPHORUS AND MINERAL SUPPLEMENT CONSUMPTION PER ANIMAL PER DAY IN GRAMS. | 51 |
| 4. | MINERAL ANALYSES PERFORMED ON COLLECTED SAMPLES | 59 |
| 5. | COMPOSITION OF THE MINERAL MIX FED DURING THE EXPERIMENT PERIOD | 67 |
| 6. | EFFECT OF DIETARY PHOSPHORUS LEVEL ON PERCENT OF COWS PREGNANT BY YEAR | 71 |
| 7. | INFLUENCE OF DIETARY PHOSPHORUS LEVEL AND SEASON ON BODY WEIGHT (kg) IN COWS (YEARS 2 AND 3) | 73 |
| 8. | INFLUENCE OF DIETARY PHOSPHORUS LEVEL ON SERUM MINERAL CONCENTRATIONS FOR COWS BY YEAR | 75 |
| 9. | INFLUENCE OF DIETARY PHOSPHORUS LEVEL AND SEASON ON SERUM MINERAL CONCENTRATION FOR COWS. | 79 |
| 10. | SERUM MINERAL CONCENTRATIONS OF CALVES AS AFFECTED BY DIETARY PHOSPHORUS LEVELS OF THEIR DAMS BY YEAR. | 81 |
| 11. | INFLUENCE OF DIETARY PHOSPHORUS LEVEL AND COW CLASS ON SERUM MINERAL CONCENTRATIONS. | 84 |
| 12. | INFLUENCE OF DIETARY PHOSPHORUS LEVEL ON LIVER MINERAL CONCENTRATION BY YEAR | 86 |
| 13. | INFLUENCE OF DIETARY PHOSPHORUS LEVEL ON BONE MINERAL CONTENT, PERCENT ASH AND SPECIFIC GRAVITY (S.G.) BY YEAR | 88 |

Table Page

14. INFLUENCE OF DIETARY PHOSPHORUS LEVEL ON HAIR SELENIUM CONCENTRATION AS RELATED TO YEARS. . . . . 90

15. SOIL MACROMINERAL, ORGANIC MATTER (OM) AND PH CONCENTRATIONS AS RELATED TO SEASON AND YEAR. . . . 97

16. FORAGE MACROMINERAL, CRUDE PROTEIN (CP), AND IN VITRO ORGANIC MATTER DIGESTIBILITY (IVOMD) CONCENTRATIONS AS RELATED TO SEASON AND YEAR . . . 101

17. SOIL TRACE MINERAL CONCENTRATIONS AS RELATED TO SEASON AND YEAR. . . . . 110

18. FORAGE TRACE MINERAL CONCENTRATIONS AS RELATED TO SEASON AND YEAR. . . . . 113

19. SOIL MACROMINERAL, ORGANIC MATTER (OM) AND PH CONCENTRATIONS BY MONTH AND YEAR (ppm). . . . . 121

20. FORAGE MACROMINERAL, CRUDE PROTEIN (CP) AND IN VITRO ORGANIC MATTER DIGESTIBILITY IVOMD CONCENTRATIONS BY MONTH AND YEAR (%) . . . . . 126

21. SOIL TRACE MINERAL CONCENTRATIONS AS RELATED TO MONTH AND YEAR (ppm) . . . . . 136

22. FORAGE TRACE MINERAL CONCENTRATIONS AS RELATED TO MONTH AND YEAR (ppm) . . . . . 138

23. SUMMARY GUIDE TO MINERAL REQUIREMENTS FOR RUMINANTS (DRY BASIS) . . . . . 153

24. COW MEAN WEIGHTS (kg) AS RELATED TO TREATMENT, YEAR AND SEASON . . . . . 154

25. CALF WEIGHTS AT MARKING AND BRANDING BY SEX AND YEAR. . . . . 155

26. OVERALL BONE AND BONE/SERUM MINERAL CORRELATION COEFFICIENTS. . . . . 156

27. OVERALL SERUM AND LIVER/SERUM MINERAL CORRELATION COEFFICIENTS. . . . . 157

28. OVERALL LIVER MINERAL CORRELATION COEFFICIENTS. . . 158

29. SOIL/FORAGE MACROMINERAL CORRELATION COEFFICIENTS.. 159

Table Page

30. SOIL/FORAGE TRACE MINERAL CORRELATION COEFFICIENTS. 160

31. SOIL MINERAL, ORGANIC MATTER (OM) AND PH CORRELATION COEFFICIENTS. . . . . 161

32. FORAGE MINERALS, CRUDE PROTEIN (CP) CORRELATION COEFFICIENTS. . . . . 162

LIST OF FIGURES


| Figure | | Page |
|---|---|---|
| 1. | THE LOCATION OF DESERET RANCHES OF FLORIDA WITH RESPECT TO KISSIMMEE AND MELBOURNE. . . . . | 165 |
| 2. | FORAGE CP AND IVOMD CONCENTRATIONS MONTHLY VARIATION (1987-1988) . . . . . | 166 |
| 3. | MACROMINERAL CONCENTRATION IN FORAGE MONTHLY VARIATION (1987-1988) . . . . . | 167 |
| 4. | FORAGE Cu, Fe, Mn AND Zn CONCENTRATIONS MONTHLY VARIATION (1987-1988) . . . . . | 168 |
| 5. | FORAGE Co, Mo AND Se CONCENTRATIONS MONTHLY VARIATION (1987-1988) . . . . . | 169 |

Abstract of Dissertation Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

EFFECT OF DIETARY PHOSPHORUS LEVEL ON PERFORMANCE OF GRAZING CATTLE AND MINERAL STATUS OF SOILS AND FORAGES IN CENTRAL FLORIDA

By

J. Edmundo Espinoza

May 1990

Chairman: Dr. Lee R. McDowell
Major Department: Animal Science

A three-year experiment was conducted at Deseret Ranches in central Florida to determine the effect of supplemental phosphorus on performance of breeding beef cows and to evaluate animal mineral status based on forage, soil and animal tissue analyses. In year 1 samples were collected in May and November. For years 2 and 3 soils and forages were sampled monthly. Three herds of crossbred beef cows were fed a complete mineral supplement containing different concentrations of phosphorus: low phosphorus (LP) at 4-6%, medium phosphorus (MP) at 8% and high phosphorus (HP) at 12%. The LP group had a lower ($P<.05$) pregnancy rate in year 1 but pregnancy rates were similar for all treatment ($P>.05$) in years 2 and 3. Cows from HP group had heaviest ($P<.05$) weights in November. November body weights were higher

(P<.01) than May weights for all groups. Deficiencies were found for cow serum magnesium in LP and for phosphorus in MP and HP groups in both seasons. In calves, serum minerals most likely to be deficient were phosphorus in LP group in year 3, copper in MP group in year 2 and selenium in LP group in year 1. Pregnant cows had higher serum (P>.05) calcium in LP group, magnesium in MP and HP groups, and phosphorus in LP group. Open cows of LP and MP groups were higher in serum zinc and copper. All liver mineral concentrations were adequate, except manganese in MP group in year 2. No treatment effect (P>.05) was found for bone minerals. Low hair selenium was found in HP group in years 1 and 2. Few correlations (r>¦.5¦, P<.05) were found between bone, liver and serum minerals. Low correlations (r>.5, P<.05) were found between soil and forage minerals: calcium, magnesium, potassium, sodium, phosphorus, iron, manganese, zinc and copper. Month differences (P<.05) were found for all forage minerals. Deficient concentrations for forage production were found in soil copper, potassium, sodium, phosphorus, manganese and zinc and in forages for mature cows for all minerals except calcium, manganese and molybdenum. Results would indicate that 6% phosphorus in supplements is adequate for normal reproduction under the conditions of this experiment. Minerals most likely limiting grazing cattle production were cobalt, copper, magnesium, phosphorus, sodium and selenium.

# CHAPTER I
# INTRODUCTION

In Florida, approximately 15 millon acres of rangelands and woodlands are being grazed by domestic livestock (U.S. Department of Agriculture, 1987). The kind of grasses that are produced on these lands and the way they are used and managed have an impact on the economy of the beef cattle industry in Florida.

Undernutrition is commonly accepted to be the most important factor limiting the grazing cattle industry in warm climates (McDowell, 1985). Mineral deficiencies, imbalances and toxicities have been reported to be responsible for low production among grazing tropical cattle (Miles and McDowell, 1983; McDowell, 1976).

Probably the most widespread and certainly the most reported mineral deficiency is that of phosphorus. Cohen (1980) reported that phosphorus is probably the nutrient most frequently given as a supplement to grazing ruminants. Deficiency of this element has been indicated to be primarily a condition of grazing ruminants (Maynard et al., 1979). Under grazing conditions, most of the forage that ruminants consume is reported to be borderline to deficient in phosphorus;

consequently, phosphorus is usually one of the most limiting of the mineral nutrients for ruminants (Underwood,1981; McDowell, 1985). In Florida, a deficiency of phosphorus under practical conditions has been recognized for some time (Becker et al., 1933).

Many reports indicate that phosphorus supplementation has dramatically increased ruminant fertility and growth in many parts of the world (NRC, 1984; McDowell, 1976; Engels, 1981; Bauer et al., 1982). Other reports (Call et al., 1978; Little, 1980; Butcher et al., 1979; Pott et al., 1987) indicated that normal production can occur, even when amounts of dietary phosphorus are below that commonly recommended.

Research from Utah State University and Australia would indicate a considerably lower phosphorus requirement for beef cattle. In Australia, Little (1980) suggests a phosphorus requirement for growing cattle (daily growth rate, 0.53 kg) to be 7 g per day which would be 0.12-0.13% phosphorus on dry matter basis. The recommendations from the Agriculture Research Council (ARC) (1980) and National Research Council (NRC) (1984) are considerably higher ranging from 0.20-0.26%. Butcher et al.(1979) from Utah State University fed beef cattle for 8 years and concluded that the phosphorus requirement is between 0.09 and 0.14%. He believes that the requirement can be met at 67% of the NRC recommendation; however, 50% of the NRC requirement was sometimes not adequate. Such controversial reports concerning phosphorus

requirements suggest the need for further research, since supplemental phosphorus is the most expensive component of a mineral supplement and unneeded phosphorus supplementation can unnecessarily increase the cost of beef production.

The objectives of this study were 1) to compare the effect of feeding three levels of phosphorus supplements (4-6%, 8% and 12%) to grazing cattle on maintenance and reproductive performance of cows and the mineral status of cows and calves and 2) to evaluate soil and forage mineral concentrations over a three-year period in central Florida.

CHAPTER II
LITERATURE REVIEW

## The Role of Phosphorus in Animal Nutrition

### Functions

Phosphorus is one of the most abundant mineral elements in the animal body, exceeded only by calcium. Phosphorus has been reported to have more known functions in the animal body than any other mineral element (Harrison, 1984). In addition to uniting with calcium and carbonate to form compounds that lend rigidity to bones and teeth, phosphorus is found in every cell of the animal body and is an essential element for many metabolic processes (McDonald et al., 1981; Melvin, 1984; Shupe et al., 1988).

Approximately 80% of total body phosphorus occurs in the inorganic portion of bone as calcium phosphate [$Ca_3(PO_4)_2$] and hydroxyapatite [$Ca_{10}(PO_4)_6(OH)_2$] (Harrison, 1984; Underwood, 1981). Bones serve not only as structural elements but also as storehouses of calcium and phosphorus which may be mobilized at times when the absorption of these minerals is inadequate to meet body needs. Thus the mineral metabolism of bone involves not only the deposition of calcium and phosphorus during growth but also processes of storage and

mobilization which occurs throughout life (Maynard et al., 1979). The other 20% of body phosphorus (nonskeletal phosphorus) is found in the cell and extracellular fluids as organic phosphoric acid esters, phosphoproteins, phospholipids and inorganic phosphate ions which play key roles in metabolism (Church, 1971; Lassiter and Edwards, 1982; McDonald et al., 1981).

The nonskeletal phosphorus is a key element in high-energy containing compounds such as adenosine diphosphate (ADP), adenosine triphosphate (ATP), and creatine phosphate. It is a part of nucleic acids such as deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) (Lehninger, 1982). In all these functions, phosphorus occurs in the phosphate form ($PO_4$) (Lassiter and Edwards, 1982).

Phosphorus is also essential to all micro-organisms. It is necessary for carbohydrate fermentation and is a constituent of primary cell metabolites such as nucleotides and of coenzymes such as flavin phosphates, pyridoxal phosphate and thiamin pyrophosphate (Durand and Kawashima, 1980). It is considered that about 80% of the total phosphorus in rumen bacteria is contained in nucleic acid and about 10% in phospholipids (Van Nevel and Demeyer, 1977). The total phosphorus content of rumen micro-organisms may range from 2 to 6% on a dry weight basis and total microbial matter is generally lower than 2% (Hungate, 1966).

The amount of phosphorus entering the rumen via saliva is usually high. Durand and Kawashima (1980) reported that mean daily flow of saliva phosphorus to the rumen is about 58 g in cows and the phosphorus microbial requirement is about 34 g per day.

Absorption

There is no doubt that, like calcium, the major site of phosphorus absorption is the small intestine (Grace et al., 1974), chiefly in the proximal end, with both a sodium-requiring active transport process and diffusion involved (Walling, 1977). Absorption of phosphorus from the omasum is negligible and it has not been demonstrated from the abomasum (Cohen, 1980; Grace et al., 1974).

An important factor in the efficiency of phosphate absorption is the vitamin D status of the individual. The primary functions of vitamin D are enhancement of intestinal absorption and mobilization, retention, and bone deposition of calcium and phosphorus (McDowell, 1989; Braithwaite, 1978). Vitamin D deficiency, especially a lack of the active vitamin D metabolite, reduces the absorption of phosphate as well as of calcium (Harrison, 1984). It has been shown that cholecalciferol (vitamin $D_3$) is hydroxylated in the liver to 25-hydroxycholecalciferol (25-OH-$D_3$) and subsequently in the kidney to 1,25 dihydroxycholecalciferol (1,25 $(OH)_2D_3$) which is generally believed to be the active metabolite (Deluca and Schnoes, 1976).

The passive absorption of phosphate by the small intestine predominates at high luminal phosphate concentrations, while the active transport process is stimulated via the vitamin D pathway in animals fed low-phosphate diets. Low plasma phosphate will stimulate the synthesis of the active form of vitamin D, 1,25 dihydroxycholecalciferol independent of calcium influences. The resulting increase in 1,25 $(OH)_2D_3$ stimulates the intestine to absorb phosphate more efficiently (Reinhardt et al., 1988; Wasserman, 1981).

In contrast to calcium where absorption is tied to body needs, dietary phosphorus is absorbed by ruminants in direct relation to phosphate intake (Reinhardt et al., 1988; Miller, 1983; Cohen, 1980). Recently, Challa et al. (1989) observed that whereas the rate of phosphorus absorption was directly related to phosphorus supplied, the efficiency of phosphorus absorption differed according to the supply. Thus the absorption efficiency was low from the phosphorus-deficient basal diets, increased with phosphorus supplementation until the supply was sufficient to meet requirements and then decreased at higher rates of phosphorus supply, possibly as a result of homeostatic control.

The degree of phosphate absorption is influenced also by the intake of cations that form insoluble phosphates in the intestinal contents. Reinhardt et al. (1988) reported that high intakes of dietary calcium, magnesium, aluminum, and iron

will form insoluble complexes with phosphate, although the low pH of the ruminant duodenum may increase the solubility of calcium-phosphorus salts compared with that in monogastric animals. Other factors that influence phosphorus absorption are Ca:P ratio, intestinal pH, lactose intake, source of phosphorus, and dietary intake of calcium, phosphorus, vitamin D, iron, aluminum, manganese, potassium, magnesium, zinc and fat (Irving, 1964; Miller, 1983).

Endogenous Losses

Unlike many species, the ruminant does not depend on the kidney as a major route of phosphorus excretion, its role being supplanted largely by the salivary glands (Reinhardt et al., 1988). Ruminants recycle large amounts of phosphorus as inorganic phosphate in saliva, in which secretion appears to be regulated by parathyroid hormone (PTH) (Wasserman, 1981). The amount of saliva secreted by cattle is in the range of 25 to 190 l per day, which represents 70 to 80% (30 to 40 g) of the total endogenous phosphate (Wadsworth and Cohen, 1977, cited by Reinhardt et al., 1988). Braithwaite (1984) reported that salivary secretion of phosphorus was related directly to phosphorus absorption and increased at a rate of 1 mg/day/kg body weight for each 1 mg/day/kg body weight increase in absorption. This finding supports the suggestion that the inevitable endogenous fecal loss of phosphorus, in animals fed exactly according to their phosphorus requirements, is not constant but varies in direct relation to the rate of

phosphorus absorption, and hence to the phosphorus intake needed to supply these requirements. Reinhardt et al. (1988) reported that the total output of phosphate in saliva is a function of many factors. When normal to high levels of dietary phosphorus are consumed, phosphate absorption is related directly to the amount of phosphate in the diet and also is related directly to the plasma phosphate concentrations. There is, however, an inverse relationship to saliva flow (Thomas, 1974; Thomas et al., 1967).

Factors that reduce the flow of saliva (for example, fasting) can divert part of the endogenous phosphate excretion from saliva to urine (Miller, 1983; Thomas et al., 1967). The salivary phosphate mixes with the dietary phosphate before a portion of the total is absorbed during its passage through the small intestine. Thus, factors that influence the absorption of dietary phosphate also affect absorption of endogenous phosphate secreted from the salivary glands (Reinhardt et al., 1988). The NRC (1989) indicated that the concentration of phosphorus in saliva may reach five times or more that in plasma. The salts of phosphoric acid in saliva are the most important buffering system in the rumen (Annison and Lewis, 1959).

In contrast to monogastric animals, most of the endogenous phosphorus in ruminants is excreted through the feces and varies with the amount of phosphorus consumed (ARC, 1980). Braithwaite (1984) reported that endogenous loss of

phosphorus in feces is directly related to both phosphorus intake and phosphorus absorption but, inversely related to phosphorus demands.

The endogenous phosphorus present in feces generally is considered to be unabsorbed digestive juice phosphorus, secreted mainly in the saliva. However, not all endogenous phosphorus lost in feces is secreted as part of the homeostatic mechanism. Some loss is unavoidable, and because urinary excretion is normally low, this unavoidable loss represents the major part of the ruminants' maintenance requirement (Braithwaite, 1984). Although recognizing that phosphorus absorption varies in direct relation to intake, the ARC (1980) made the assumption that the unavoidable part of the endogenous fecal loss is equal to that loss which would occur at zero phosphorus intake. They estimated minimum endogenous losses for weaned cattle to be 10 mg/kg of live weight in the feces and 2 mg/kg of live weight in the urine, thus establishing a maintenance requirement of 1.43 g/100kg of live wight.

Scott and McLean (1981) have indicated that urinary phosphorus loss is not related to phosphorus intake but is normally associated with a higher than normal efficiency of absorption. Challa et al. (1989) reported that phosphorus may be eliminated in urine only when phosphorus requirements for maintenance and growth had been met fully. Another possible explanation for increased urinary excretion of

phosphorus was suggested by Field (1981). He observed that certain individual sheep which absorb phosphorus more efficiently than normal also excrete high quantities of phosphorus in the urine and he suggested that urinary phosphorus excretion occurred when the salivary secretion mechanism was saturated.

Requirements

The economic importance of phosphorus to the grazing ruminant lies in such practical considerations as growth rate, reproductive performance, skeletal and dental health, milk yield and wool growth. Many reports have indicated increased fertility, better growth, and improved general herd health if cattle are given natural feeds relatively high in phosphorus or supplemental phosphorus (NRC, 1976; Preston, 1976). There are numerous literature reports concerning the metabolic influence of phosphorus on animal performance. Many of these reports are old and contradictory. Ovarian dysfunction and reduced fertility in cattle receiving low phosphorus diets were reported by Theiler et al. (1928), Kleiber et al. (1936), Hignett and Hignett (1952) and Short and Bellows (1971). According to Preston (1976), fertility and calving rates are quite sensitive to phosphorus intake. Reduced weight gains in cattle receiving phosphorus deficient diets were reported by Holzochuh et al. (1971), Morrison (1956), and Winks and Laing (1968). Inappetence was reported by Morrison (1956). Other research reports indicate that there is normal production,

even with dietary phosphorus concentrations below those commonly recommended (Palmer et al., 1941; Eckles et al., 1935; Engels, 1981; Call et al., 1978).

The contradictory reports are due, at least in part, to difficulty in maintaining individual phosphorus intake and the arduous problem of developing an uncomplicated phosphorus deficiency and defining the resulting physiopathology (Call et al., 1978).

In spite of much information reported during recent decades, there has been little research to define mineral requirements, particularly using practical diets. Underwood (1981) indicated that mineral requirements are affected by the species or breed of animal, the intensity or rate of production permitted by other aspects of the diet or the environment, and by the criteria of adequacy employed. The same author considers that adequate calcium and phosphorus nutrition depends not only on sufficient total dietary supplies, but also on the chemical forms in which they occur in the diet and on the vitamin D status of the diet or the animal. The dietary Ca:P ratio also can be important.

Estimates for the requirements for phosphorus by beef cattle have been published by the ARC (1980) in the UK and by the NRC (1984) in the USA. Although they differ they are widely used and accepted by those concerned with beef cattle nutrition. McDowell et al. (1978) summarized the mineral requirements for ruminants (appendix A table 23). When the

requirements of phosphorus are expressed as concentration of the diet, the NRC (1984) estimates range from .18 to .70% for growing finishing steers and heifers and from .31 to 40% for lactating dairy cows. The ARC (1980), on the other hand, express values as g/day; these values range feom 8 to 29 g/day for cattle gaining at different rates, from 11 to 22 g/day for pregnant cows and from 29 to 75 g/day for lactating cows. Phosphorus requirements for livestock are calculated by the factorial method and the feeding experiment method (ARC, 1980). With the factorial method, the net quantity of phosphorus for livestock is calculated as the sum of the phosphorus retained by the animal, phosphorus lost in animal products (conceptus and milk) and endogenous phosphorus losses (feces and urine). This value is adjusted to the availability of dietary phosphorus. Phosphorus retention during growth is estimated from data on the phosphorus content of animals of different weights and stages of pregnancy (Cohen, 1980). In the feeding-experiment method, the response of animals is studied when various amounts of the mineral are fed (McDowell, 1985).

It has been suspected for some time, however, that the standards applying to dietary phosphorus requirements are too high. Recently, Call et al. (1986) indicated that common recommendations for dietary phosphorus, such as those outlined by the NRC (1984) (17.5 g of P/day over the entire year for cows weighing 450 kg), exceed the basic requirements for beef

cattle. They consider that 12 g of P/day is adequate for a 450 kg beef cow. There is also controversy over the ARC (1980) recommendations on phosphorus requirements for ruminants, which are considerably lower than previous recommendations (ARC, 1965) and are considered by many researchers as being too low (Braithwaite, 1985, 1986). Recently, Challa et al. (1989) indicated that their findings add support to the previous suggestions made by Braithwaite (1985, 1986), and they concluded that phosphorus recommendations of the ARC(1980) are too low, particularly for growing animals.

Research from Utah and Australia would indicate a considerably lower phosphorus requirement for beef cattle. Little (1980) from Australia suggests a phosphorus amount for growing cattle (daily growth rate, .53 kg) to be 7 g per day which would be .12-.13% P on a dry matter basis. The recommendations from ARC (1980) and NRC (1984) would be considerably higher, ranging from .20-.26%. In Utah, Butcher et al. (1979) fed beef cattle for eight years and concluded that the phosphorus requirement is between .09-.14%. He believes that the requirement can be met at 67% or higher of the NRC recommendation. However, 50% of the NRC requirement was sometimes not adequate.

Some work (McDowell et al., 1984) is in disagreement with the low phosphorus requirements from Utah and Australia. In 17 studies, breeding cows supplemented with phosphorus had an average calving percentage 25% higher than controls. Forages

were generally higher in phosphorus than .09-.14%, but cows still responded to phosphorus supplementation. Recently in Florida, Williams (1987) conducted an experiment using Angus heifers fed either .11 or .19% dietary phosphorus for 2.5 years. Although production performance was not severly affected, the mean linear density ($g/cm^3$) of the metacarpal bones was 1.49 vs 1.65 for the .11 and .19% phosphorus treatments, respectively. Therefore for breeding animals, .11% phosphorus would not be adequate, as bone demineralization occurred at this level.

Judkins et al. (1985) reported results of a supplementation trial of Angus X Hereford range cows over a 5 year period in New Mexico. These authors observed that fertility was not affected by phosphorus supplementation. However, no data were reported on forage intake or phosphorus content of forages. Call et al. (1987) studied the effect of three dietary phosphorus concentrations (.24, .32 and .42%, dry matter basis) on performance of lactating dairy cows for up to 12 months. The authors reported that the pregnancy rate in the .24% phosphorus group was superior to both other treatment groups, 92% compared to 87 and 76% for the .32 and .42% phosphorus groups, respectively. Also, cows on the lower phosphorus diet required fewer breedings per pregnancy.

In many studies where phosphorus supplementation on pasture was reported to be beneficial, the inability to state the phosphorus intake from the pasture has been a major

problem in studying the minimum phosphorus requirements for pregnancy and lactation. Nevertheless, it is clear that adequate phosphorus in the diet is essential for good animal health and production.

The maximum tolerable level of phosphorus for cattle is 2% of the dry matter. Excess of this element may cause bone disorders and reduced feed consumption (NRC, 1984).

Deficiency

Phosphorus deficiency is a very serious economic problem for grazing livestock in many parts of the world. McDowell et al. (1984) reported phosphorus deficiency of grazing ruminants in many areas of the world including Africa, Australia, North America and South America.

Phosphorus deficiency is predominantly a condition of grazing ruminants, especially cattle, whereas calcium deficiency is more a problem of hand-fed animals, especially pigs and poultry. Lassiter (1982) and Underwood (1981) indicated that phosphorus deficiency occurs primarily as a result of ruminants grazing on plants grown on soils low in plant-available phosphorus. The resulting herbage is very low in phosphorus, and this deficiency may be further accentuated by dry periods and by the low phosphorus content that results as the plants mature and shed their seed.

Characteristics of severe deficiency are similar for both calcium and phosphorus. Signs of phosphorus deficiencies are not recognized easily except in severe cases (McDowell, 1985).

Many reports (Maynard et al., 1979; Lassiter, 1982; McDowell, 1985; Underwood, 1981) indicated that clinical signs of phosphorus deficiency are characterized by fragile bones (skeletal and dental abnormalities), general weakness, weight loss, emaciation, stiffness, reduced milk production, abnormal chewing of objects ('pica' or depraved appetite), and rickets in young and osteomalacia in older animals. Phosphorus deficiency was also reported from Florida. Becker et al. (1933) described signs indicative of phosphorus deficiency in cattle, and reported that affected animals were stiff, lame, and were chewing bones, oyster shells, wood, or rocks.

McDowell (1985) reported that reduction of appetite will have the result of reduced energy and protein intakes and, consequently, loss of weight. Conversely, despite normal phosphorus intake, bone mineralization may be restricted by inadequate intakes of energy and protein. This is in agreement with Underwood (1981) who indicated that the protein content of the herbage declines with the phosphorus, so that protein deficiency, and frequently also a deficiency of available energy, are exacerbating factors in the malnutrition of livestock in phosphorus-deficient areas.

In addition to the interaction between calcium and phosphorus, the availability of different sources of these minerals and interrelationships with additional mineral elements or nutrients, deficiency of phosphorus is influenced by vitamin D supply (McDowell, 1985; Underwood, 1981). The

importance of calcium and phosphorus interaction and the implication of parathyroid hormone and the active vitamin D metabolite was discussed by Cohen (1980). He suggested that when calcium intake is high, the production of 1,25 $(OH)_2$ $D_3$ is depressed with a consequent reduction of phosphorus absorption, parathyroid hormone secretion, salivary phosphorus concentration and mobilization of phosphorus from bone. Thus, if phosphorus level is low under these conditions, hypophosphorosis will develop. Conversely, when dietary calcium is low there is increased production of 1,25 $(OH)_2$ $D_3$ and absorption of phosphorus, increased secretion of parathyroid hormone and salivary phosphorus concentration plus mobilization of phosphorus from bone. These actions result in increased available phosphorus for soft tissue metabolism so that responses to phosphorus supplementation are less likely even though dietary phosphorus concentration is low.

Underwood (1981) reported that dietary Ca:P ratio between 1:1 and 2:1 is assumed to be ideal for growth and bone formation since this is approximately the ratio of the two minerals in bone. Actually ruminants can tolerate a wide range of Ca:P ratios, particularly when their vitamin D status is high. Wise et al. (1963) have indicated that dietary Ca:P ratios between 1:1 and 7:1 all gave satisfactory and similar results but with ratios below 1:1 and over 7:1, growth and feed efficiency decreased significantly.

Supplementation

The primary nature of phosphorus deficiency has been established thoroughly in South Africa by Theiler et al (1928), and has been confirmed in many other areas. The preventative and curative effects of phosphorus supplements have been demonstrated and adequate information is available on means of providing supplements for cattle (McDonald, 1968). McDowell (1985) indicated that the most devastating economic result of phosphorus deficiency is reproductive failure, with phosphorus supplementation dramatically increasing fertility levels in grazing cattle.

Cohen (1987) concluded that adequate macrominerals in the diet are essential for good animal health and reproduction. Further, the cost of providing them is so insignificant in relation to the provision of other nutrients that there is little reason not to provide them at all times for grazing livestock. Beef production in many parts of the world depends almost exclusively on the extensive natural rangelands found in the major beef producing countries. Animal production in such environments is seriously limited because of essential nutrient deficiencies in the pasture (van Nikerk, 1974). The phosphorus requirement of a grazing ruminant is rarely met by forages; therefore, supplementation is necessary (McDowell, 1985). Provision of a phosphorus supplement to grazing beef cattle requires consideration of the requirements of the different categories of livestock, the amount of

available phosphorus in the present diet, the cost of the supplements and the method of their administration (Jubb and Crough, 1988).

Phosphorus deficiency can be prevented or overcome by direct treatment of the animals through supplementation of the diet or the water supply or, indirectly by appropriate fertilizer treatment of the soils on which the pastures to be consumed are grown (McDowell, 1985). Several phosphate sources have been used in the tropics and subtropics with some difference in their effectiveness. Bone meal has been used widely as a supplement and is clearly palatable and easily utilized. Disodium and monosodium phosphates have been investigated widely, both in solid and solution form, and have been generally effective especially in cases where herbage calcium is high. The use of both phosphoric acid and diammonium phosphate appear to be associated with some problems, especially in the case of the former, because of a disturbance of acid-base balance. Similarly, the use of rock phosphates and superphosphates must be treated with caution because of the provocation of digestive disturbances as well as the presence of fluorine which may be toxic (Butterworth, 1985).

There are a wide variety of phosphorus supplements listed in the literature. The choice among local options will be determined by their availability, continuity of supply, and relative cost and safety , particularly with respect to

fluorine. (Jubb and Crough, 1988). The Association of American Feed Control Officials has set a P:F ratio of at least 100:1 as the standard for safe concentrations of fluorine in feed phosphates.

In extensive range conditions where fertilizer applications are uneconomical as in many areas of Latin America, Asia, and Africa, McDowell (1985) suggested that direct provision of additional phosphorus can be achieved by the use of phosphate containing supplements as part of free-choice mineral mixtures.

It is often difficult for researchers to asses the extent of a problem in a particular area and to introduce the most economical corrective measures. To prove a ration is deficient in phosphorus they must be able to demonstrate a positive response to phosphorus supplementation in the animals being fed. But obviously, a lack of response does not necessarily show adequacy of the diet, which also may be deficient in protein, energy, or other essential nutrients. Also, the animal may exhibit normal production responses because phosphorus is being withdrawn from the bone to prevent metabolic disturbances.

## Assessment of Mineral Status in Ruminants

Clinical signs of mineral deficiencies, pathological and biochemical examinations, along with soil, water, plant

and animal tissue and fluid mineral analyses all have been used with varying degrees of success to establish mineral deficiencies and excesses. However the majority of mineral imbalances, particularly borderline conditions, do not result in pathological observations or clinical signs specific to a single mineral. Therefore, in order to determine mineral insufficiencies, chemical analyses and biological assays often are required (McDoell et al., 1986)

It has been difficult for mineral nutritionists to develop simple and accurate biochemical measurements of an animal's mineral status as there are important practical problems (Miller and Stake, 1974). Reid and Horvath (1980) reported that no mineral concentration of any one tissue will portray the status of all minerals. Therefore, since homeostatic control of mineral utilization is exercised in different ways for each element, the selection of organs or fluids for analyses which reflect the nutritional status of the animal is very important.

Forage mineral analyses are preferable to soil analyses, while appropriate animal tissue and fluid analyses most accurately portray the contribution of the total dietary environment (forage, soil, water, etc.) in meeting livestock mineral requirements (McDowell et al., 1986).

In the following discission all tissue concentrations given are for cattle unless otherwise specified.

Blood Serum Minerals

With the development of methods for the analysis of blood, a valuable tool has been placed in the hands of experimenters in physiology and nutrition and of physicians in the clinical laboratory (Anderson et al., 1930). Underwood (1981) indicated that mineral values in blood plasma or serum which are consistently and significantly above or below the so-called normal concentration provide suggestive but not conclusive evidence of a dietary excess or deficiency of a particular mineral.

Calcium and phosphorus

Despite some limitations, blood inorganic phosphorus concentration has been used extensively and, because of practical considerations, probably will be the most useful diagnostic procedure in assessing phosphorus status in cattle (Teleni et al, 1976). Similarly, Underwood (1981) suggested that phosphorus status of grazing animals is determined best by blood inorganic phosphorus levels. In contrast, Garnet et al. (1965) and Cohen (1973) reported that plasma phosphorus levels do not reflect adequately phosphorus status. Lane et al. (1968) and Mylrea and Bayfield (1968) indicated that inorganic phosphorus in plasma is affected by factors other than dietary phosphorus, such as age, milk yield, pregnancy, season, and breed. Forar et al. (1982) considered that changes in plasma inorganic phosphorus need to be determined to

increase the usefulness of inorganic phosphorus as an indicator of nutritional phosphorus status.

Underwood (1981) indicated that the first response to a dietary deficiency of phosphorus is a fall in the inorganic phosphate fraction of the blood plasma and a withdrawal of calcium and phosphorus from the reserves found in the bones. Accompanying this decline is a rise in plasma phosphatase, a small rise in serum calcium concentration, from a normal 9-10 to 13 or 14 mg/100 ml. The author also suggested that the normal values for plasma inorganic phosphorus are 4-6 mg/100 ml for adults and 6-8 mg/100 ml, for very young animals.

Cunha et al. (1964) from Florida, suggested that mean serum calcium levels of 10-12 mg/100 ml are normal for healthy cattle, while levels below 8 mg/100 ml were suggestive of a calcium deficiency . From a study of four regions in Florida, Kiatoko et al. (1982) reported plasma phosphorus values of 5.1, 5.8, 5.4 and 6 mg/100 ml for the Southeast, Southwest, Central and Northwest regions, respectively. From a recent study in Florida, Williams (1987) reported blood serum phosphorus values of 4.05 and 5.05 mg/100 ml and serum calcium values of 9.52 and 9.50 mg/100 ml for three weeks postpartum cows receiving low and high dietary phosphorus, respectively.

Magnesium

Extracellular fluids contain about 1% of the total magnesium in the body. Excessive loss of magnesium from the extracellular fluid pool can result in tetany. Hypomagnesemia

occurs when dietary magnesium absorption , owing to frank deficiency or interference, fails to replace magnesium exiting via milk, fetal growth, or endogenous fecal and salivary loss (Reinhardt et al., 1988).

The NCMN (1973) indicated that magnesium status of ruminants is assessed best from magnesium concentrations in blood and urine. Underwood (1981) reported that serum magnesium concentrations below 1.7 mg/100 ml were found in cattle suffering hypomagnesemic tetany, and he considered that tetany will occur more likely at concentrations below 1.0 mg/100 ml. The NCMN (1973) suggested that in healthy animals with adequate magnesium nutrition, normal serum magnesium concentration could vary from 2.0 to 3.5 mg/100 ml. Values below 2.0 mg/100 ml are considered deficient, and values below 1.0 mg/100 ml are extremely deficient. Similarly, Littledike et al. (1983), cited by Reinhardt (1988), indicated that normal magnesium concentrations in plasma of cattle range from 1.7 to 3.3 mg/100 ml.

From Florida, Cunha et al. (1964) suggested that serum magnesium concentrations of 2.5 mg/100 ml are normal in cattle. Recently, Merkel (1989) found no difference in serum magnesium concentrations between October to November (2.00 mg/100 ml) and March to April (1.98 mg/100 ml) collections.

Many factors have been shown to interfere with magnesium absorption. Reinhardt et al. (1988) reported factors that affect magnesium absorption to include potassium, nitrogen,

energy, increased fatty acids, water, and the organic acid content of the diet. Chicco et al. (1973) reported that high dietary calcium depressed magnesium concentration in plasma and bone. Newton et al. (1972) indicated that high dietary potassium (4.9%) resulted in reduced magnesium retention and plasma magnesium.

Zinc

Zinc is widely distributed throughout the body and plays an essential role in many body processes. Zinc deficiency signs have been reported in ruminants under practical conditions. Mills et al. (1967) found that zinc levels in plasma respond very rapidly to dietary changes.

According to NCMN (1973), zinc status of animals could be assessed by zinc determination in blood plasma, with values of .6 to 1.4 ppm indicating a normal zinc status. Underwood (1981) indicated that zinc concentrations in serum or plasma are a good indicator of zinc deficiency. He added that normal values range from .5 to 1.2 ppm. However, Apgar and Welch (1982), cited by Smith et al. (1988), indicated that serum or plasma zinc concentrations are not sensitive to marginal zinc deficiencies. According to Spears (1989) marginal zinc deficiencies appear to be a more widespread occurrence.

Under Florida conditions, McDowell et al. (1982) reported plasma zinc values varying from 1.0 ppm for the wet season to .9 ppm for the dry season. Merkel (1989) in Charolais cattle

found higher serum zinc values during October-November (.91 ppm) than in March-April (.63 ppm).

Variation in plasma zinc may be due to hyperthermia, mastitis and ketosis. Wagner et al. (1973) reported that dairy cows under hyperthermal stress showed a decrease in plasma zinc. They also found that cows suffering from mastitis have higher plasma zinc values than healthy cows.

Copper

In the plasma fraction of blood, 70-90% of the copper is accounted for by the copper containing enzyme ceruloplasmin (Frieden, 1980, cited by Painter, 1982). The most widely used criteria for copper deficiency is the concentrations of copper in liver and in blood. Whole blood or plasma copper concentrations reflect the dietary copper status (Underwood, 1981). A positive relationship was found between liver and plasma copper concentrations. Liver copper on the order of 40 ppm were necessary to maintain plasma copper concentrations of .91 ppm. Plasma copper concentrations below .50 ppm were suggestive of low liver copper content (Claypool et al., 1975).

The normal range of whole blood or plasma copper in cattle is from .60 to 1.50 ppm with most values between .80 and 1.20 ppm (Underwood, 1981). According to the NCMN (1973), plasma copper concentrations of .60 to .75 ppm may be considered slightly deficient while values below .40 ppm are suggestive of copper deficiency. McDowell (1985) indicated

that a serum copper concentration of .65 ppm is considered a critical level for cattle.

From Florida, Cunha et al. (1964) suggested that normal blood copper concentration in the healthy mature bovine is .75 ppm. Salih et al. (1986) found serum copper values ranging from .60 to .65 ppm over three supplementation treatments. From the North Central region of Florida, Merkel et al (1990) reported Charolais cows had lower values ranging from .45 to .72 ppm for October-November and March-April sampling dates, respectively.

Signs of copper deficiency include poor growth, diarrhea, loss of hair color and fetal resorption. Copper deficiency also results in anemia, less liver copper, and increased liver iron stores (Underwood, 1977). Blood copper concentration can be affected by many factors including age, pregnancy, diseases as well as dietary copper, molybdenum and sulfur (Kincaid et al., 1986; McDowell et al., 1983). Ward (1978) reported that physiological copper deficiencies are produced by four classes of feeds: 1) high molybdenum, above 100 ppm; 2) low copper:molybdenum ratio, 2:1 or less; 3) copper deficiency, below 5 ppm; and 4) high protein, 29-30%.

Selenium

Historically, selenium deficiencies in cattle have been associated with white muscle disease. Selenium is an integral part of the enzyme glutathione peroxidase (GSH-px) and both

GSH-px and vitamin E protect cell membranes from oxidative damage caused by peroxides (Langlands, 1987).

Langlands (1985), cited by Smith et al. (1988), suggested that plasma or serum selenium concentrations are more indicative of current selenium intake than blood. However, Smith et al. (1988) suggested that plasma selenium levels of .07 ppm divide the sufficient and insufficient concentrations in dairy cattle. McDowell et al. (1983) suggested serum selenium concentration below .03 ppm to be critical for beef cattle.

Perry et al. (1976) reported that plasma selenium content increased with dietary selenium. They found that supplementation of steers with 0, .1, .2 and .4 ppm selenium resulted in a respective increase of plasma selenium from .024 ppm in control animals to .073 ppm in animals fed .4 ppm selenium. From Florida, Salih (1984) reported higher serum selenium values in calves at prenursing (.086 ppm) and at three days after prenursing (.03 ppm) than when they were three months old (.015 ppm). Merkel (1989) reported serum selenium values in calves of .025 ppm at 6-8 weeks and .067 ppm at 32-34 weeks of age.

Mineral Status in Liver

The liver is the metabolic center of minerals in the body. Therefore the liver is an ideal indicator of the status of certain trace elements of grazing livestock since microelements are too low in blood and their determination is

often subject to some analytical errors (Boyazoglu et al., 1972). Similarly, McDowell et al. (1986) indicated that liver taken either by biopsy or from sacrificed animals is an excellent indicator of the status of certain trace elements.

Iron

Iron is present in all cells of the body and plays a key role in many biochemical reactions. Hallberg (1984) indicated that varying amounts of iron are stored as ferritin or hemosiderin in liver.

Interest in the iron requirement centers primarily on the needs of the young animal maintained on milk or milk substitutes (ARC, 1980). The iron reserves of the calf (mainly in liver) are generally sufficient to prevent serious anemia if calves are fed dry feeds (NRC, 1989). McDowell et al.(1978) indicated that iron deficiency is unlikely to occur in older ruminants except in circumstances involving blood loss.

Hartley et al. (1959) reported that the normal level of iron in liver ranges from 180 to 340 ppm (DMB). Ammerman (1970) reported liver iron levels of 100 to 300 ppm (DMB) in Florida cattle in an adequate state of copper nutrition. McDowell et al. (1980) suggested values less than 180 ppm (DMB) as a critical level. From a study in the Southeast region of Florida, McDowell et al. (1982) reported liver iron values of 283 ppm in the wet season and 425 ppm (DMB) in the dry season. Also from Florida, Salih (1984) found liver iron

values of 653 ppm for the wet season and 548 ppm (DMB) for the dry season.

Cunha et al. (1964) indicated that liver iron content is closely related to copper status. They found that in cattle on adequate copper and iron nutrition, normal liver level of iron is in the range of 200 to 300 ppm (DMB) while in copper deficient animals, liver iron can increase up to 10,000 ppm. Rosa et al. (1982) found that high dietary zinc reduces iron storage.

Copper

Copper is an essential nutrient in all animals that have been studied. The liver is the storage organ of copper, and fetal liver is particularly rich in copper (O'Dell, 1984). Liver copper content would provide a useful index of the copper status in livestock (Underwood, 1981). Mayland et al. (1987) indicated that approximately 20% of the copper in plasma is in a loosely bound form while the other 80% is associated with the protein ferroxidase I (ceruloplasmin). This protein oxidizes ferrous iron ($Fe^{++}$) to ferric ($Fe^{+++}$) allowing the mobilization of iron stores.

According to the NCMN (1973), liver copper concentrations (DMB) on the order of 200 and 150 ppm are considered normal for yearling cattle and for heifers and cows, respectively. The same authors reported that liver copper values of 25 ppm are considered as marginal while liver copper values below 10 ppm are usually followed by severe clinical signs of copper

deficiency. Underwood (1981) indicated that normal liver copper values vary from 100 to 400 ppm (DMB).

From Florida, Cunha et al. (1964) indicated that normal liver copper content in cattle with good copper nutrition status be between 100 and 300 ppm (DMB). Copper values of 75 ppm could be considered as marginal while values below 25 ppm (DMB) copper were accompanied often by severe clinical copper deficiency signs. Also from Florida, McDowell et al. (1989) reported liver copper values of 317 ppm for the summer-fall season and 250 ppm (DMB) for the winter-spring season.

Manifestations of copper deficiency are described by Underwood (1981). Deficiencies can arise from insufficient copper in the forage and/or from excessive concentrations of elements which interfere with copper absorption and utilization, in particular molybdenum and sulfur.

Manganese

Manganese is widely distributed in very low levels in cells and tissues of an animal's body. According to NCMN (1973) liver tissue seems to be the most promising criterion for assessing the manganese status of animals. The ARC (1980) indicated that the highest concentrations of manganese are found in liver, hair and skeleton.

According to Underwood (1977), the normal level of manganese in cattle liver (DMB) is in the range of 8 to 10 ppm, levels below 8 ppm indicate deficiency. Egan (1975) reported that a liver manganese values below 6 ppm indicate

deficiency. McDowell et al. (1985) concluded that liver manganese value of 6 ppm is accepted generally as a critical level.

From Florida, McDowell et al. (1982) reported liver manganese values of 8.4 ppm for the wet season and 10.3 ppm for the dry season. Also in Florida, McDowell et al. (1989) found liver manganese values of 11.5 and 10.5 ppm for the summer-fall and for the winter-spring season, respectively.

Manganese deficiency has been found in every species tested. One of the first reported effects of manganese deficiency was that of skeletal abnormalities (Underwood, 1977).

Cobalt

The only known function of cobalt is as part of the vitamin $B_{12}$ molecule (Underwood, 1981). Vitamin $B_{12}$ is a metabolic essential, but is not a dietary essential for cattle and sheep because it is synthesized adequately by rumen microorganisms. Thus the cobalt deficiency is actually a vitamin $B_{12}$ deficiency (Maynard et al., 1979). Conrad (1978) suggested that liver cobalt content is sufficiently responsive to changes in cobalt intake. Ammerman (1981) indicated that a decrease of liver cobalt and vitamin $B_{12}$ are indicative of a dietary cobalt deficiency.

Underwood (1981) suggested that livers of cobalt-deficient sheep and cattle generally contained less than .08 ppm cobalt (DMB) whereas concentrations were usually .2 to .3

ppm cobalt in healthy animals. Cunha et al. (1964) reported that normal levels of liver cobalt should be .2 ppm while levels of .07 ppm should be considered as borderline, and .04 ppm as a severe cobalt deficiency. McDowell (1985) suggested that liver cobalt levels between .05 and .07 ppm are deficient, while those above .07 ppm are normal. Under Florida conditions, Salih (1984) found liver cobalt values of .63 and .43 for the wet and the dry seasons, respectively.

Cobalt deficiency is associated with specific soil types and is observed in all climatic zones. Forage concentrations less than .07 mg cobalt per kg dry matter are inadequate for sheep and somewhat lower concentrations are inadequate for cattle (Langlands, 1987).

Molybdenum

Molybdenum is an essential constituent of xanthine oxidase, aldehyde oxidase and sulfite oxidase ; the activities of these enzymes decline in experimental deficiency (Nielsen and Mertz, 1984). Xanthine oxidase, a molybdenum-containing metaloprotein is essential for the metabolic degradation of purines to uric acid, and it is present in liver and intestinal tissue (Maynard et al., 1979).

Underwood (1977) indicated that normal liver molybdenum levels are 2 to 4 ppm. McDowell (1985) suggested that liver molybdenum values above 4 ppm are indicative of excess. From Florida, Salih (1984) found that mean liver molybdenum

contents were 3.0 and 2.6 ppm during the wet and the dry seasons, respectively.

Toxicosis is the main concern in molybdenum nutrition. Manifestations of clinical signs of molybdenum toxicosis in cattle include diarrhea, anorexia, achromotrichia, and posterior weakness (NRC, 1980). Underwood (1977) indicated that molybdenum toxicity generally occurs in cattle grazing pastures with 20 to 100 ppm molybdenum but not in cattle grazing normal pasture with 3 to 5 ppm molybdenum or less.

Maynard et al. (1979) reported that feeding excess molybdenum brought on the clinical signs of copper deficiency and interfered with copper metabolism. The mechanism or mechanisms through which sulfur interacts with molybdenum to reduce copper retention by the animal still are not fully understood.

Zinc

After an extensive review on zinc in animal tissues and fluids, Underwood (1977) found that liver was the major organ involved in zinc metabolism.

Powell et al. (1964) reported that liver zinc values between 84 and 150 ppm are considered to be normal. Meanwhile, liver zinc values above 125 ppm were considered to be normal by Underwood (1977). From Florida, McDowell et al. (1982) reported liver zinc values of 100.8 and 106.9 ppm for the summer and winter seasons, respectively. Also in Florida,

McDowell (1989) found liver zinc values of 103 ppm for the summer-fall season and 99 ppm for the winter-spring season.

Zinc deficiency is probably more common in grazing ruminants than previously expected (McDowell et al., 1983). Deficiencies are difficult to diagnose and may be manifested by depressed intake, retarded growth and reproductive disorders (Underwood, 1981). The ARC (1980) indicated that requirements for zinc will be met fully by rations providing approximately 30 mg of zinc per kg of dry matter.

Selenium

Langlands (1987) suggested that fluids and liver reflects selenium status in animals. Underwood (1977) reported that liver and kidney contain high concentrations of selenium and they are very sensitive to dietary selenium. McDowell et al. (1990) indicated that soil and forage selenium concentrations provide information as to the status of the element for ruminants and that concentrations of selenium in serum, liver, hair, regular milk and colostrum reflect supplemental intakes. Andrews et al. (1968) indicated that liver selenium values less than .25 ppm (DMB) are indicative of deficiency. Conrad et al. (1978) suggested that liver selenium concentrations greater than .1 ppm are considered normal. McDowell et al. (1985) listed liver selenium values of .25 ppm as critical. From Florida, McDowell et al (1982) reported liver selenium values of .30 and .28 ppm for the summer and the winter seasons, respectively. From the same

general region, McDowell et al. (1989) reported liver selenium values of .34 and .33 ppm for the summer and dry seasons, respectively.

Dietary requirements of selenium range from .1 to .3 ppm (DMB), and supplements of selenite and selenate are regularly added to diets (NRC, 1980). Concentrations in forage below .05 mg selenium per kg dry matter should be considered as low and may result in muscular dystrophy, stiffness in the limbs, inability to stand, depressed growth, infertility and sudden death (Langlands, 1987). The same author indicated that selenium toxicity is associated with seleniferous soils, the consumption of plant species which accumulates selenium, and most commonly with the inappropriate administration of selenium supplements.

Bone Minerals

Calcium and phosphorus

Problems of phosphorus deficiency in cattle are widespread, but there is as yet no satisfactory method of objectively assessing the status of bovine phosphorus reserves (Little, 1984). An accurate method for assessing calcium and phosphorus status of grazing ruminants is important. Many scientists consider that the rib bone biopsy technique (Little, 1972) is a more reliable method for assessing the phosphorus status of grazing cattle than blood or hair (Cohen, 1973; Read et al., 1986; McDowell, 1985). Langlands (1987)

considers that the vertebrae and ribs are more sensitive than long bones to changes in calcium and phosphorus status.

Underwood (1981) reported that withdrawal of calcium and phosphorus from the bones during periods of inadequate intake does not take place equally from different parts of the skeleton. The spongy bones, ribs, vertebrae and sternum, which are the lowest in ash, are the first to be affected.

Maynard et al. (1979) indicated that in mammals the bone is made of approximately 36% calcium, 17% phosphorus and .8% magnesium (dry, fat-free bone). Little (1972) suggested 11.5% phosphorus (dry, fat-free basis) in bone as a critical level. From Panama, Ammerman et al. (1974) reported values from 37.6 to 38.2% calcium and from 17.6 to 18.1% phosphorus in bone ash. Mendez (1977) found that calcium levels in cattle bone ranged from 22.7 to 24.8% and phosphorus from 9.38 to 10.1% when expressed as percent of dry, fat-free bone.

Little (1972) reported that expressing calcium and phosphorus concentration per unit volume has greater sensitivity than on a dry, fat-free basis. Also, Little (1984), based on experiments with cattle, proposed that the concentration of phosphorus in total fresh ribs (RPC) be adopted as a criterion of the phosphorus reserves of cattle. The author indicated that 5% phosphorus or more appears to indicate adequate reserves.

It was reported that the amount of phosphorus in bone is influenced by pasture calcium content. Cohen (1973) suggested

that bone phosphorus below 14.3, 13.5, and 12.7% of the dry fat-free bone may represent a phosphorus deficiency state when pasture calcium contents are .18, .15, and .12%, respectively.

Magnesium

Magnesium storage in the adult ruminant is .3-.5 g/kg liveweight, 70% of which is located in bones and the remainder widely distributed in fluids and soft tissue (Maynard, 1979; Langlands, 1987). There is little information concerning tissue levels of magnesium but NRC (1980) suggested that bone magnesium may indicate long term magnesium status.

Blaxter and Sharman (1955) suggested that normal magnesium concentration in rib bones of cattle range from .67 to .70% on dry, fat-free basis. From Brazil, Mendez (1977) reported bone magnesium content varied from .46 to .49% on a dry, fat-free basis. From Florida. Williams et al. (1990) indicated magnesium concentrations of .49 and .55% in rib ash for low and high phosphorus supplemented cows, respectively.

Dietary magnesium requirements are influenced by several factors including breed, age, rate of production, magnesium status of the animal and availability of the element in the diet (Underwood, 1981). The same author indicated that the minimum dietary needs of magnesium would be met by a diet containing .07% or 700 ppm magnesium (DMB).

Hair Selenium

Selenium concentration in hair also reflects dietary intakes of selenium (Underwood,1977; Langlands, 1987). Hair

from normal cows contains 1-4 ppm selenium compared with 10-30 ppm for cattle in seleniferous areas (Underwood, 1981). Hidirogluo et al. (1965) found that cows with hair selenium concentrations of between .06 and .25 ppm (DMB) produced calves with white muscle disease while cows with hair selenium higher than .25 ppm had normal calves. Perry et al. (1976) found hair selenium values in the order of .30, .49, .58 and .60 ppm in steers fed 0, 0.1, 0.2, and 0.4 ppm selenium, respectively. From Florida, Kiatoko (1979) reported hair selenium concentrations of .178 and .108 ppm for the wet and the dry seasons, respectively. Salih (1984) found hair selenium values of .125 and .403 ppm for the summer and the winter seasons, respectively.

## Mineral Status of Soils and Plants

It has been reported that mineral concentrations in both soils and plants affect the mineral status of grazing livestock (Towers and Clark, 1983). The mineral composition of forage plants is affected by soil-plant factors including pH, drainage, fertilization, forage species, forage maturity and interaction among minerals (Gomide, 1978; Reid and Horvath, 1980).

Reid and Horvath (1980) indicated that the availability of minerals in soils depends upon their effective content in soil solution. Soil analyses alone cannot be used to reliably

diagnose mineral deficiencies in livestock (Towers and Clark, 1983). In agreement with this, McDowell et al. (1986) stated that the concentration of a mineral in a soil is an uncertain guide to its concentration in the forage. Therefore, forage mineral analyses are preferable to soil analyses.

Macrominerals

The mineral soils of subtropical Florida are dominated by Spodosols and Entisols. With the exception of organic soils, the soils are acid, infertile and sandy in texture (Fiskel and Zelazny, 1972). Soil acidity problems are associated with pH levels lower than 5.5 and the presence of exchangeable aluminum in the soil (Sanchez, 1976). Liming of the soil is usually the best solution to soil acidity problems.

In general, with the exception of very acid soils (pH below 5.0), soil calcium content is adequate for most pastures. Poor growth of plants on acid soils is usually caused by excesses of soluble manganese, iron and/or aluminum rather than calcium content (Warncke and Robertson, 1976). Phosphorus deficiency is mainly caused by fixation of phosphates by free sesquioxides of iron and aluminum (Dudal, 1977).

For Florida soils, Breland (1976), cited by De Sousa (1978) reported that calcium contents from 0 to 71 ppm are considered low; 72 to 140 ppm are medium, and 141 ppm or more are high. For phosphorus, soils with 0 to 5 ppm are considered

very low, 6 to 12 ppm low, 14 to 25 ppm medium, and 26 to 50 ppm very high. In general, soils containing more than 30 ppm of available phosphorus are normal (Gomide, 1978). Forage calcium content of .25 to .30% and phosphorus of .30% (DMB) has been considered to be adequate in grazing areas (Conrad, 1978; NRC, 1976)).

Gomide (1978) indicated that clay and organic soils are rich in potassium, while sandy soils are frequently deficient. Warncke and Robertson (1976) suggested that a soil is considered to be medium in potassium when it contains between 80 and 120 ppm potassium. Forage potassium concentration changes during growth for physiological reasons independent of the soil potassium level (Grimme, 1978). Normal potassium content in forage range from 1.0 to 2.5% of the dry matter. Clanton (1980) suggested that forage potassium contents of .5-.7% are adequate for gestating cows.

Magnesium uptake by plants depends on the amount present, the degree of saturation, the nature of the other exchangeable ions, and the type of clay (Tisdale, 1975). For Florida soils, values from 0-9.1 ppm are considered low, 9.2 to 21.1 ppm medium , and above 22.2 ppm high (Breland, 1976). Kiatoko et al. (1982) reported soil magnesium values of 29.6 ppm for the Southeast region of Florida. The minimum magnesium concentration in forage was suggested to be .2% of the dry matter (Underwood, 1966; Karlen et al., 1980). Kiatoko (1982)

reported values of .19 and .14% magnesium in forage for the wet and dry seasons, respectively.

Sodium is one of the most loosely held of the metallic ions and is readily lost through leaching. Its presence in soils in high quantities is restricted to arid and semi-arid regions (Tisdale and Nelson, 1975). In general forages are low in sodium and a deficiency in forages is common. The NRC (1976) suggested .06% forage sodium values as critical. Merkel et al. (1990) reported soil sodium values of 9.6% for the Northern region of Florida. Kiatoko et al. (1982) found a range of .07 to .18% sodium in forage over four regions in Florida.

Trace Minerals

Copper in soils is found as the cupric ion ($Cu^{+2}$) and it is in this form that copper is absorbed usually by plants (Tisdale and Nelson, 1975). Factors that affect copper content in soils include parent material, organic matter, clay content and pH (McLaren et al., 1983). The copper content in soils ranges from 2 to 50 ppm , with a mean value of 20 ppm (Reid and Horvath, 1980). Rhue and Kidder (1983) suggested that .3 ppm copper in soils as critical. Normal copper content in plants range from 8 to 20 ppm and deficiencies may occur at values below 6 ppm (Jones, 1972). Underwood (1981) reported that copper deficiency can arise when high intakes of molybdenum and sulfur occur coupled to normal copper intake.

The iron content in forages as in soils, varies widely and can be greatly affected by contamination with soil and dust (Jones, 1972). Iron deficiency is rare for grazing ruminants due to a generally adequate concentration in forage (McDowell et al. 1984). Soil iron content is highly variable. Viets and Lindsay (1973) suggested 2.5 ppm iron in soils as critical. McDowell et al. (1982) reported mean soil iron values ranging from 12.1 to 51.9 ppm from four soil orders in Florida. Jones (1972) suggested that if forage iron values are below 50 ppm, deficiency is likely to occur. McDowell et al. (1982) found forage iron values of 130.6 ppm for the wet season and 127.2 ppm for the dry season.

Selenium in plants depends not only on soil factors but is influenced also by plant species, maturity, yield and climate (Ammerman et al., 1978). Factors that affect the selenium concentrations in soils are the selenium content of host rocks, pH, and nature of the drainage waters (Cooper et al., 1974). Cary et al. (1967) indicated that soil selenium content less than .5 ppm is prevalent in areas of selenium deficiency. McDowell et al. (1982) suggested soil selenium values of .2 ppm as critical. Ganter (1974) suggested that selenium values of .1 to .5 ppm in the forage should be considered protective, but non-toxic for livestock.

Several factors affect zinc uptake by plants. An increase in soil pH by liming reduces the availability of zinc to plants. Also, zinc deficiency is observed frequently on high

phosphate soils (Olsen, 1972). From Florida, Street and Rhue (1980) reported that total soil zinc is in the range of 10 to 300 ppm. Normal ranges of zinc content in plants are from 20 to 150 ppm, while toxicity may develop if zinc values exceed 400 ppm (Jones, 1972; Rhue and Street, 1980). McDowell et al. (1982) reported mean forage zinc values of 19.7 and 23.6 ppm for the wet and dry seasons respectively.

Manganese uptake by plants is affected by soil acidity. In soils with a pH around 4.0 manganese is more available. Also, higher concentrations of organic matter cause an increase in manganese solubility (Leeper, 1947). Soil manganese concentrations vary widely, ranging from 20 to 6000 ppm (Street and Rhue, 1980). From Florida, Mooso (1982) reported soil manganese values ranging from .9 to 2.2 ppm. Manganese content in forages is extremely variable. This variation is due to species differences as well as soil and fertilizer effects (Underwood, 1977). The NRC (1976) reported that most forages contain more than 30 ppm manganese which is adequate to meet the requirement of 10 to 20 ppm manganese for heifers and cows.

Cobalt plays an important role in nitrogen fixation by bacteria (Brady, 1984). McDowell et al. (1982) reported soil cobalt values ranging from .09 to .12 ppm for the fall season and from .12 to .26 ppm for the winter season. Houser et al. (1978) suggested that forage cobalt concentrations less than .10 ppm should be considered deficient. Becker et al. (1965),

from Florida, reported that pastures with "salt sick" cattle had .000 to .035 ppm forage cobalt. The NRC (1980) indicated that under practical conditions, cobalt deficiency in ruminants is more likely than cobalt toxicosis. Possibly toxic dietary concentrations are above 10-15 ppm (DMB).

Molybdenum availability is high on alkaline soils (Kubota et al., 1967). Underwood (1977) suggested that at low levels of molybdenum (below .2 ppm), copper toxicity may develop. Large (1972) reported that a soil level of .4 ppm is adequate for most crops. Under Florida conditions, forage molybdenum concentrations vary widely. Becker et al. (1965) found values ranging from 1 to 160 ppm.

Organic matter is the main source of cation exchange sites in Florida soil. Cation exchange capacity is increased with increase in pH, particularly in surface soils (Fiskell, 1970). Fiskell and Zelazny (1971) indicated that the increase in cation exchange capacity is attributed to increase in pH dependent charges on the organic matter. Popenoe (1960) indicated that parent material, topography and climate may have a significant effect on soil pH.

## CHAPTER III
## MATERIALS AND METHODS

### Description of the Experiment

The experiment was conducted at Deseret Ranches of Florida, which is a 128,000 hectare commercial cow-calf operation located in Osceola County in Central Florida. The ranch is owned and operated by the Church of Jesus Christ of Latter Day Saints. The location of the ranch in relation to the state of Florida is shown in Fig. 1.

The objectives of this experiment were to determine the effect of different phosphorus concentrations of mineral supplements on performance of breeding beef cows and to evaluate their mineral status on the basis of forage, soil and animal tissue analyses.

Three herds of approximately 200-250 breeding animals each were assigned randomly to three treatment groups. Crossbred cattle were 1/4 to 3/8 Brahman with British breeds of Angus, Hereford and Charolais. Bulls were Simmenthal X Brahman (1/2) crossbreds. Animals were more than three years old, and raised at Deseret Ranches. Each group was fed ad libitum with a complete mineral supplement (tables 1 and 2) containing different concentrations of phosphorus. Initially

TABLE 1. MINERAL COMPOSITION OF MINERAL MIX FED DURING THE FIRST YEAR OF THE EXPERIMENT (%)[a]

| Ingredients[b] | Treatments | | |
|---|---|---|---|
| | Low Phosphorus | Medium Phosphorus | High Phosphorus |
| Calcium, not less than | 12.00 | 12.00 | 12.00 |
| Phosphorus, not less than | 4.00 | 8.00 | 12.00 |
| Salt, not more than | 15.00 | 15.00 | 15.00 |
| Copper, not less than | .20 | .20 | .20 |
| Cobalt, not less than | .003 | .003 | .003 |
| Selenium, not more than | .002 | .002 | .002 |
| Iron, not less than | .70 | .60 | .60 |
| Manganese, not less than | .20 | .20 | .20 |
| Iodine, not less than | .01 | .015 | .015 |
| Zinc, not less than | .50 | .50 | .50 |
| Magnesium, not less than | .67 | .50 | .50 |
| Potassium, not less than | .85 | .70 | .70 |
| Fluorine, not more than | .03 | .11 | .15 |

[a]The supplement was manufactured by "Lakeland Cash Feed Company, Inc"., Lakeland, Fl.

[b]Dicalcium Phosphate, Monocalcium Phosphate, Cane Molasses, Calcium Carbonate, Cottonseed Meal, Salt, Copper Sulfate, Cobalt Sulfate, Sodium Selenite, Iron Sulfate, Zinc Sulfate, Ethylene Diamine Dihydriodide, Sulfur, Potassium Sulfate, Manganous Oxide, and Magnesium Sulfate.

TABLE 2. MINERAL COMPOSITION OF THE MINERAL MIX FED DURING THE SECOND AND THIRD YEARS OF THE EXPERIMENT (%)[a]

| Ingredients[b] | Treatments | | |
|---|---|---|---|
| | Low Phosphorus | Medium Phosphorus | High Phosphorus |
| Calcium, not less than | 12.00 | 12.00 | 12.00 |
| Phosphorus, not less than | 6.00 | 8.00 | 12.00 |
| Salt(NaCl), not more than | 15.00 | 15.00 | 15.00 |
| Copper, not less than | .20 | .20 | .20 |
| Cobalt, not less than | .003 | .003 | .003 |
| Selenium, not more than | .002 | .002 | .002 |
| Iron, not less than | .60 | .60 | .60 |
| Manganese, not less than | .20 | .20 | .20 |
| Iodine, not less than | .015 | .015 | .015 |
| Zinc, not less than | .50 | .50 | .50 |
| Magnesium, not less than | .50 | .50 | .50 |
| Potassium,not less than | .70 | .70 | .70 |
| Fluorine, not more than | .07 | .11 | .15 |

[a]Prepared by "Lakeland cash Feed Company, Inc.", Lakeland, Florida.

[b]Dicalcium Phosphate, Monocalcium Phosphate, Cane Molasses, Calcium Carbonate, Cottonseed Meal,Salt, Copper Sulfate, Cobalt Sulfate, Sodium Selenite, Iron Sulfate, Zinc Sulfate, Ethylene Diamine Dihydriodide, Sulfur, Potassium Sulfate, Manganous Oxide, and Magnesium Sulfate.

for the first year (year 1) of the experiment, the three treatments consisted of the following phosphorus concentrations (DMB) in the mineral supplements:

1. Low Phosphorus(LP) 4% P
2. Medium phosphorus(MP) 8% P
3. High phosphorus(HP) 12% P

Because of the low calving percentages observed in the LP group following the first year of the experiment, the phosphorus concentrations were changed and the phosphorus concentration in mineral supplements for the second and third years were as follow:

1. Low phosphorus(LP) 6% P
2. Medium phosphorus(MP) 8% P
3. High phosphorus(HP) 12% P

The mineral mix was fed in covered pens installed in the respective pastures. The mineral mix offered was periodically sampled for chemical analyses. Amount of mineral consumption per animal for each group was estimated from the total supplement fed and the average number of animals for the given pastures ( Table 3). Animals were provided free-access to water throughout the experimental phase. During the first year of the experiment, cows were weighed only in November and no calf weights were recorded. For the second two years, animals were weighed twice a year (May and November) and calves were weighed once a year (May) at the time of marking and branding.

TABLE 3. PHOSPHORUS AND MINERAL SUPPLEMENT CONSUMPTION PER ANIMAL PER DAY IN GRAMS[a]

| YEARS | | TREATMENTS | | |
|---|---|---|---|---|
| | | Low Phosphorus | Medium Phosphorus | High Phosphorus |
| Year 1 | Supplement | 39.8 | 26.1 | 21.0 |
| | Phosphorus | (1.59)[b] | (2.09) | (2.51) |
| Year 2 | Supplenet | 26.1 | 28.0 | 19.8 |
| | Phosphorus | (1.57) | (2.24) | (2.38) |
| Year 3 | Supplement | 21.0 | 20.1 | 21.1 |
| | Phosphorus | (1.26) | (1.61) | (2.53) |

[a]Calculated based on the total supplement consumed and the average number of cows per year.

[b]Figures in parenthesis indicates the amount of phosphorus (in grams) from the supplement consumed per animal per day.

Before weighing the animals were corralled overnight without access to feed or water.

Energy and protein supplements were provided to all animals of the three treatments for 90 days during the winter (December 15 to March 15) of each year . The supplement consisted of .45 kg cottonseed cubes (33 percent protein) per animal per day and 1.8 kg molasses (Blackstrap, no urea) per animal per day.

All animals were bred naturally. Each herd was comprised of a different number of cows (appendix A,table 24), but one bull was provided for every thirty cows. Animals were vaccinated against Red water and Lepto-vibrio every year and measures for control of flies and worms were applied every 6 months.

Approximately 200 hectares were assigned to each treatment group for the whole experimental period. Pastures were divided for rotational purposes. Animals grazed year round on pastures predominantly of bahiagrass (Paspalum notatum) at a stocking rate of 1 ha per cow. In the spring of the first and second year, pastures were fertilized with 20-10-10 ($N-P_2O_5-K_2O$) at the rate of 100 kg per ha for the first year and 125 kg per ha for the second year. For the third year, pastures were fertilized with 25-18-0 ($N-P_2O_5-K_2O$) at the rate of 100 kg per ha. Pastures were not burned during the three years of the experimental period.

Pregnancy of cows was determined once a year by rectal palpation during the fall . Nonpregnant cows were culled at the end of each year with selected animals from each treatment providing blood, bone, liver, hair and fecal samples. Cows were weighed twice a year (May and November) and calves in May only. Body weights recorded by weighing all animals in groups varying from 5 to 12 each time.

## Sample Collection

Soil and forage samples were collected twice in 1986 (May and November), then from January, 1987 through December 1988 forage and soil samples were collected every month. Blood samples were collected twice a year (May and November) for the three years. Liver, bone, hair and feces were collected once a year (November) from 6 to 7 culled cows per treatment. Approximately 200 acres were assigned to each treatment group for the whole experimental period. Pastures were divided for rotational purposes.

### Soil Samples

Using the soil sampling technique cited by Bahia (1978), three composite soil samples from each pasture were collected twice a year in 1986 and every month in 1987 and 1988. A stainless steel soil sampling tube was used to take soil samples; the depth of the soil sample was similar to the length of the forage root system, approximately 10 to 15 cm.

Each of the three composite soil samples for each pasture came from 6 to 8 samples. Samples were collected in plastic bags and brought to the University of Florida where they were dried, passed through a 2 mm sieve and stored in paper bags for further analyses.

A total of 42 soil samples was collected in the first year of the experiment (21 in May and 21 in November, 3 samples from each of 7 pastures assigned to the experiment). In the second and third year a total of 252 soil samples per treatment per year was collected (21 samples per month).

Forage Samples

Forage and soil samples were collected at the same time and at the same site. The main improved forage specie in all pastures in which the experimental animals grazed was bahiagrass (Paspalum notatum); however, to a lesser (less than 5% of total) extent, all pastures were associated with native grasses and legumes including broomsedge bluestem (Andropogon virginicus), Chalky bluestem (Andropogon capillipes), creeping bluestem (Andropogon stolonifer), and a legume Desmodium sp.

Three composite forage samples were collected for each of the sampling periods from each pasture as indicated for soil sample collections. Forages were collected based on a careful observation of cattle grazing patterns in order to obtain a representative sample of forage species and plant parts being consumed by the animal. Forage sub-samples of about 50 g each were taken with stainless-steel scissors from

the area where the soil samples were being taken. The forage samples were cut at a height of 3 to 6 cm. The three composite samples for each pasture weighing about 300 g each, were placed in a cloth bag for air drying and brought to the Nutrition Lab of the U. of Florida, where the samples were dried at 60 °C for 48 h. Samples were ground using a wiley mill with a 1 mm stainless-steel sieve; ground material was mixed and stored in whirl-pak type plastic bags for further chemical analyses.

Animal Tissue Samples

Liver, bone, blood serum, hair and feces samples were collected from culled cows once a year (November). Blood serum samples were collected from 46 cows randomly selected twice a year (May and November) and from 15 calves also randomly selected once a year (May) from each treatment group. The handling facilities at the ranch were satisfactory, and they facilitated a rapid sample collection. In general it took 3 to 4 hours to collect bone and liver biopsies, blood, hair and feces from 6-7 animals from each treatment group.

Liver biopsy

Each year 6 to 7 nonpregnant culled cows were selected for liver sample collection from each group. Liver samples were taken in vivo using a liver biopsy technique described by Fick et al. (1979). Liver biopsy samples of approximately 1 to 2 g (wet weight) were separated from blood and other tissues, placed in a small bottles, identified, cooled, and

then transported to the U. of Florida, where they were frozen until analyzed.

Bone biopsy

Bone biopsy samples were taken using a modified surgical procedure described by Little (1972). Six to seven rib cortical bone biopsy samples were taken from each treatment group every year. The bone samples were removed from the left side of the animals at the 12th rib using a 1.4 cm diameter stainless-steel trephine. Bone samples were wrapped in .9% saline soaked gauze, placed in a plastic bag, identified and placed in a cooler containing ice, transported to the U. of Florida and stored frozen until analyses. Since the bone biopsy technique involved a surgical procedure, lidocaine was injected to each animal (5 ml IM) prior to the sample collection; then, iodine solution (50%) was used to disinfect the wound.

Blood samples

Blood samples were collected by jugular vein puncture using 15 gauge California Bleeding needles and serum separation tubes according to the procedures proposed by Fick et al. (1979). Prior to centrifugation blood samples were left standing for 20 minutes, then serum was separated by centrifugation at 2500 rpm for 20 minutes. Serum samples were identified, cooled and then brought to the Nutrition lab and stored frozen until further analyses. Serum samples were obtained twice a year (May and November) from cows having

original tag and once a year from calves (May). A total of 46 samples were collected from each herd in each collection time, plus 6-7 more samples which were obtained from the same animals used for bone and liver sampling. Fifteen samples were obtained from calves per treatment per year.

Hair samples

Hair samples were collected once a year (November) from the left flank of the animal by clipping about a 30 $cm^2$ area using electric clippers. Six to seven samples were collected from culled cows of each herd each year. Hair was stored at room temperature in whirl-pak type plastic bags until analyzed.

Mineral supplement samples

Mineral supplement samples were collected twice a year from bags prior to distribution in the feeders. Approximately 200 g of sample was taken from various bags for each treatment formula. Samples were stored in plastic bags at room temperature for further analysis.

## Sample preparation and Chemical Analysis

Forage samples and animal tissue samples collected during the experiment were brought to the Nutrition Lab at the University of Florida for preparation and analysis. Soil samples, after preparation at the Nutrition lab, were brought to the IFAS extension soil testing lab for chemical analysis.

A summary of all mineral analyses performed on samples collected during the experiment is shown in Table 4.

Animal Tissue Samples

Blood serum samples were deproteinated with 10% trichloroacetic acid (TCA) and 1% Lanthanum cloride ($LaCl_3$) and analyzed for mineral content (Table 4) according to methods described by Fick et al. (1979). Calcium, copper, magnesium, and zinc were analyzed by atomic absorption spectrophotometry using a Perkin-Elmer 5000 (Perkin-Elmer, 1980). Phosphorus concentration was determined by colorimetric procedure described by Harris and Popat (1954). Selenium concentration in blood serum was determined using the modified fluorometric procedure of Whetter and Ullrey (1978).

Liver biopsy samples were prepared according to the method described by Fick et al. (1979) and analyzed for mineral content (Table 4). Liver copper, iron, manganese and zinc concentrations were determined using a Perkin-Elmer AAS 5000 (Perkin-Elmer, 1980). Cobalt and molybdenum concentrations were determined by flameless atomic absorption spectrophotometry using a Perkin-Elmer 3030 graphite furnace with Zeeman background correction (Perkin-Elmer, 1984). Selenium concentration in liver was determined following the same procedure described for blood serum.

TABLE 4. MINERAL ANALYSES PERFORMED ON COLLECTED SAMPLES.

| Sample | Element(s) |
|---|---|
| Serum[a] | Ca, P, Mg, Cu, Zn, Se |
| Liver[b] | Fe, Cu, Mn, Zn, Co, Mg, Se |
| Bone[b] | P, Ca, |
| Hair[b] | Se |
| Forage | Ca, P, Mg, Na, K, Fe, Mn, Cu, Zn, Co, Mo, Se, S |
| Soil | Ca, P, Mg, Na, K, Fe, Mn, Cu, Zn, Al |

[a]Selenium in serum was analyzed only in calves and in culled cows.

[b]Analyzed in samples from culled cow.

Bone biopsy samples were stripped of all soft tissue with a stainless steel scapel. Then bone specific gravity, expressed in $g/cm^3$, was determined for each sample using a Mettler density determination kit[1]. Fresh bone samples were dried at 105 °C overnight then ether extracted in a soxhlet apparatus for 48 h. Bone ash and mineral content were determined subsequently following the method described by Fick et al. (1979). Phosphorus, calcium and magnesium concentrations in bone ash were determined using methods similar to those used for blood serum samples.

Hair samples were washed with shampoo, soaked in a solution of acationox[2] for 30 minutes, washed with distilled water, washed again with distilled water, and dried in an oven at 60 °C for 3 days. Hair samples were analyzed only for selenium following the modified fluorometric procedure of Whetter and Ullrey (1978).

Forage Samples

Forage samples were prepared and analyzed for mineral concentrations following the methods described by Fick et al. (1979). Calcium, magnesium, potassium, sodium, iron, manganese, copper, and zinc concentrations were analyzed by

---

[1]Mettler Instruments Corporation, Density determination Kit ME-40290, Hightstown, NJ.

[2]A metal-free nonionic detergent compound, contains less than .002% of sodium, potassium, calcium or magnesium. American Scientific Products. McGaw Park IL 60085.

atomic absorption spectrophotometry on a Perkin-Elmer AAS 5000 (Perkin-Elmer, 1980). Cobalt and molybdenum were analyzed by flameless atomic absorption spectrophotometry on a Perkin-Elmer 3030 graphite furnace with Zeeman background correction (Perkin-Elmer, 1984). Nitrogen and phosphorus concentration in forage were determined by measuring total nitrogen and phosphorus on a Technicon Autoanalyzer II, following the method described by Gallagher et al. (1975) and Technicon Industrial Systems (1978). Multiplication of nitrogen concentration by the factor 6.25 was the procedure for calculating crude protein content. Selenium concentration was determined following a modification of the fluorometric method described by Whetter and Ullrey (1979). Forage in vitro organic matter digestibility (IVOMD) was determined by the IFAS Forage Evaluation Support Laboratory according to a modification of the two-stage Tilley and Terry (1963) technique by Moore and Mott (1974). Sulfur concentration was determined at the University of Minnesota using a LECO model SC 132 sulfur analyzer, Warrendale, PA. Dry matter was determined by drying forage samples for 15 h at 105 °C and organic matter by ashing for 16 h at 550 °C.

Soil Samples

Soil samples were prepared and analyzed following the procedures used by IFAS extension soil testing laboratory at the University of Florida (Rhue and Kidder, 1983). Soil samples were analyzed for calcium, phosphorus, magnesium,

sodium, potassium, iron, manganese, copper, zinc, aluminum, organic matter, and pH. Minerals were extracted from soil using Mechlich I extracting solution method (.05 N HCL + .25 N $H_2SO_4$). Soil mineral concentrations were then determined by the Inductively Coupled Argon Plasma (ICAP) in a Thermo Jarrel Ash, model 9000 (Jarrel-Ash division, 1982)

Mineral Supplement Samples

Mineral supplement samples were prepared following the procedures set forth by Fick et al. (1979). The minerals analyses procedures used correspond to those used for forage samples with the exception of phosphorus. Phosphorus was determined by the colorimetric method described by Fick et al. (1979).

Reference material (e.g. tomato leaves and bovine liver) from the National Bureau of Standards (NBS) was included as an internal standard with all samples analyzed for mineral content.

## Statistical Analysis

Forage, soil and animal samples were collected during 3 consecutive years from three groups of cows, grazing in three different pastures and each receiving mineral supplement with different phosphorus concentrations as previously described.

Liver, bone, hair, calf serum, soil and forage data were statistically analyzed by least squares analysis of variance

using the General Linear Model procedure of the Statistical Analysis System (SAS Institute, Inc., 1987) for personal computers using PROC GLM and BY YEAR statements. A completely randomized design (Snedecor and Cochran, 1980) was used in the analysis with the following basic model:

$$Y_{ij} = u + T_i + E_{ij}$$

where,

$Y_{ij}$ = jth response of ith treatment.

$u$ = overall mean

$T_i$= fixed effect of ith treatment

$E_{ij}$= random component of error

Least square means were calculated and used to determine differences among treatment effects in liver, bone, and calf serum. Duncan's multiple range test was used to determine differences among month and year effects in soil and forage (month effects of years 2 and 3). Correlation coefficients of relationship between liver/blood serum and bone/blood serum components were estimated using the PROC CORR procedure of SAS (1987).

Forage and soil data were collected on two or more occasions per year. These data were analyzed using a 3 by 2 factorial design (Snedecor and Cochran, 1980). Year effect in forage (among years 1, 2 and 3), treatment effect in body weight and serum (among LP,MP, and HP), seasonal effect (between May and November), and their interaction were

accessed using PROC GLM in SAS (SAS Institute, Inc., 1987). The basic model used in the analysis was as follows:

$$Y_{ijk} = u + A_i + B_j + AB_{ij} + E_{ijk}$$

where,

$u$ = overall mean;

$A_i$ = effect of ith pasture;

$B_j$ = effect of jth month;

$AB_{ij}$ = interaction effect of the jth month in the ith pasture;

$E_{ijk}$ = Random component of error.

Treatment effects and month effect (in body weight and serum), year effect and month effect (in forage and soil) were calculated by analyses of variance and the least square means were calculated and used to determine differences and the interaction effects. Correlation coefficients of forage and soil minerals and between soil and forage macrominerals and soil and forage microminerals were obtained using the PRO CORR of SAS (1987).

Body weight and serum data of cows were analyzed using the same statistical procedure and the same model as described previously for soil and forage.

The effects of treatments on the pregnancy rate were analyzed by a Log linear model (Grizzle et al., 1969), using PROC CATMOD option of SAS (SAS Institute Inc., 1987).

# CHAPTER IV
# EFFECT OF DIETARY PHOSPHORUS LEVEL ON PERFORMANCE AND MINERAL STATUS OF GRAZING CATTLE IN CENTRAL FLORIDA

## Introduction

Aphosphorosis in grazing cattle is widespread, and phosphorus supplementation is a common practice. With the exception of common salt, phosphorus is probably the nutrient most frequently given as a supplement to grazing ruminants (Cohen, 1980). Phosphorus supplementation has dramatically increased fertility levels and growth in grazing cattle in many parts of the world (NRC, 1984; McDowell, 1976; Engels, 1981; Bauer et al., 1982). Other research reports (Call et al., 1978; Little, 1980; Butcher et al., 1979; Pott et al., 1987) indicate that there is normal reproduction and production, even when dietary phosphorus concentrations are below those commonly recommended. Such reports suggest the need for further research since excess phosphorus supplementation can increase unnecessarily the cost of beef cattle production.

Mineral deficiencies, imbalances and toxicities inhibit grazing cattle production in tropical and sub-tropical areas (McDowell, 1976). Most tropical forages have been found to be borderline to deficient in many essential elements

(McDowell et al., 1983). Reports from these areas indicated that mineral supplementation to grazing cattle have resulted in improved weight gains and dramaticaly increased calving percentages (McDowell, 1985).

The purpose of this study was to compare the effect of three levels of phosphorus supplements on reproduction, changes in body weight, and mineral status of animal tissue in grazing beef cattle in central Florida during a three year period.

## Materials and Methods

A three year study was conducted at a ranch in Osceola County, Florida (Central Florida). Three herds of crossbred beef cattle over 3 years of age were assigned randomly to three treatment groups. Cattle were 1/4 to 3/8 Brahman crossed with British Breeds of Angus, Hereford and Charolais. Each group was fed ad libitum a complete mineral supplement containing different concentrations of phosphorus. The composition of the free-chice mineral mixture is shown in table 5. For year 1 the three mineral mixtures were low phosphorus (LP) of 4%, medium phosphorus (MP) of 8% and high phosphorus (HP) of 12%. Because of the low calving percentage observed in the LP group following the first year, the composition of the mineral mixture was changed so that LP group received a 6% phosphorus supplement for years 2 and 3.

TABLE 5. COMPOSITION OF FREE-CHOICE MINERAL MIXTURE (%)[a]

| Ingredients | Treatments | | | |
|---|---|---|---|---|
| | Low Phosphorus | | Medium Phosphorus | High Phosphorus |
| | YR 1 | YR 2&3 | | |
| Calcium, not less than | 12.00 | 12.00 | 12.00 | 12.00 |
| Phosphorus, not less than | 4.00 | 6.00 | 8.00 | 12.00 |
| Salt, not more than | 15.00 | 15.00 | 1 5.00 | 15.00 |
| Copper, not less than | .20 | .20 | .20 | .20 |
| Cobalt, not less than | .003 | .003 | .003 | .003 |
| Selenium, not more than | .002 | .002 | .002 | .002 |
| Iron, not less than | .70 | .60 | .60 | .60 |
| Manganese, not less than | .20 | .20 | .20 | .20 |
| Iodine, not less than | .01 | .015 | .015 | .015 |
| Zinc, not less than | .50 | .50 | .50 | .50 |
| Magnesium, not less than | .67 | .50 | .50 | .50 |
| Potassium, not less than | .85 | .70 | .70 | .70 |
| Fluorine, not more than | .03 | .07 | .11 | .11 |

[a]The supplement was manufactured by "Lakeland Cash Feed Company, Inc"., Lakeland, Fl.

[b]Dicalcium Phosphate, Monocalcium Phosphate, Cane Molasses, Calcium Carbonate, Cottonseed Meal, Salt, Copper Sulfate, Cobalt Sulfate, Sodium Selenite, Iron Sulfate.

Animals from each group received the mineral supplement from covered mineral feeders installed in their respective pasture. Mineral supplement consumed per animal per day was estimated from total supplement fed and the number of animals per pasture per year (Table 3 Chapter III). All animals grazed year round on pastures predominantly of bahiagrass (Paspalum notatum) and were provided free-access to water. Energy and protein supplements were provided to all animals for 90 days during the winter (December 15$^{th}$ to March 15$^{th}$) of each year. The supplement consisted of .454 kg of cottonseed cubes (33% protein) per animal per day and 1.82 kg of molasses (blackstrap, no urea) daily.

During the first year of the experiment, cows were weighed once a year (November), and for the second and third year weights were recorded twice a year (May and November) (Appendix A table 24). Calves were weighed once a year (May) (Appendix A table 25). Pregnancy percentage was determined once a year in late gestation (November) by rectal palpation. Blood, liver, bone, hair, and feces samples were collected from 6-7 culled cows per treatment each November. Blood samples also were collected from 50 cows, randomly selected from each treatment group twice a year (May and November). Blood samples were collected from 15 calves randomly selected from each treatment group once a year (May).

Liver samples were taken in vivo using a liver biopsy technique (Fick et al., 1979). Bone biopsy samples were taken

using a modified surgical procedure (Little, 1972). Blood samples were taken by jugular vein puncture using California Bleeding Needles (Fick et al., 1979).

Samples were prepared and chemically analyzed in the Nutrition Laboratory at the University of Florida (Table 4 Chapter III). Serum calcium, copper, magnesium, and zinc; liver copper, iron, manganese, and zinc; and bone calcium and magnesium concentrations were determined by atomic absorption spectrophotometry using a Perkin-Elmer 5000 (Perkin-Elmer, 1980). Serum and bone phosphorus were determined colorimetricaly (Harris and Popat, 1954). Selenium concentrations in serum, liver and hair were determined fluorometricaly (Whetter and Ullrey, 1978). Liver cobalt and molybdenum concentrations were determined by flameless atomic absorption spectrophotometry using a Perkin-Elmer 3030 graphite furnace (Perkin-Elmer, 1984).

Data were statistically analyzed using a completely randomized design (for liver, bone, hair and calf serum) and factorial design (for body weight and cows serum) (Snedecor and Cochran, 1980), with the General Linear Models (GLM) procedure of the SAS System (SAS Institute Inc., 1987). Treatment effects on pregnancy rate were analyzed by a Log Linear Model (Grizzle et al., 1969) using PROC CATMOD option in SAS (SAS Institute Inc., 1987). Correlation coefficients were estimated for minerals in liver, serum and bone; and between liver and serum, and bone and serum.

## Results and Discussion

### Fertility

During year 1 the MP treatment group showed highest ($P<.01$) pregnancy rates (88%) followed by HP (78%) which was higher ($P<.01$) than LP (60%) (Table 6). In years 2 and 3 no differences ($P>.05$)were observed among the three treatment groups.

Many scientists have associated reduced reproductive performance with phosphorus deficient diets. In some studies, fertility in cattle appeared to be very sensitive to phosphorus intake (Theiler et al., 1928; Short and Bellows, 1971 and Preston, 1976). On the contrary, other scientists reported that phosphorus supplementation has failed to show a diminished reproductive performance (Palmer et al., 1941; Call et al., 1978; Butcher et al., 1982 and call et al., 1987). Results observed during the first year would suggest agreement with the first proposition that low dietary phosphorus (in this case, 4% P in the mineral supplement) negatively affected reproductive performance. Results of the second and third years would suggest that 6% phosphorus in the mineral supplement is adequate for normal reproductive performance. In both conditions all animals were also receiving phosphorus from forage (14.7 g/day) and from cottonseed and molasses (4.7 g/day during winter only).

TABLE 6. EFFECT OF DIETARY PHOSPHORUS CONCENTRATION ON PERCENT OF COWS PREGNANT BY YEAR[a]

| | LP | | MP | | HP | |
|---|---|---|---|---|---|---|
| | #COWS | % | #COWS | % | #COWS | % |
| YEAR 1 | (225)[b] | | 60[e] | (224) | 88[c] | (273) |
| 78[d] | | | | | | |
| YEAR 2 | (181) | 83 | (173) | 84 | (232) | 86 |
| YEAR 3 | (194) | 88 | (189) | 87 | (198) | 82 |

[a]Pregnancy was tested via rectal palpation in late pregnancy (November).

[b]Figures in parenthesis indicate number of cows tested.

[c,d,e]For each year, means in rows having different superscripts differ P<.05.

Body Weight

There were no treatment effects (P>.05) on body weight in spring (table 7). However, phosphorus supplementation influenced body weights in November, with the HP group having the highest (P<.05) weight when compared to the MP and LP groups. As expected, as a result of going through the winter, May weights were less (P<.01) than November weights for all treatments. Treatment by season interaction effects (P<.01) were found also. Results of the present experiment are in disagreement with those of Call et al. (1978) who reported no difference in weight gain, feed intake or feed efficiency of Hereford heifers fed either .14 or .36% phosphorus (as-fed) over a two year period. Similar results were observed by Little (1980), who reported that beef cattle receiving only Stylosanthes humilis (.12%P) had similar dry matter intake and liveweight gain compared to those animals supplemented at the rate of 5 g of phosphorus per day. No differences were observed in either body mass or reproductive performance between supplemented (lick consisting of 44% salt, 44% dicalcium phosphate and 12% molasses powder) and unsupplemented (salt) cattle in a region where phosphorus was not deficient in soil and grass (Marion and Engels, 1985). Butcher et al. (1979) reported that appetite and growth were reduced only when dietary phosphorus concentration was reduced to .09%.

TABLE 7. INFLUENCE OF DIETARY PHOSPHORUS CONCENTRATION AND SEASON ON BODY WEIGHT (kg) OF COWS (YEARS 2 AND 3)[a]

| Month | LP | | MP | | HP | |
|---|---|---|---|---|---|---|
| | Mean | SE[b] | Mean | SE | Mean | SE |
| May | 394[g] | 5.6 | 389[g] | 5.9 | 387[g] | 5.6 |
| November | 422[df] | 5.9 | 431[df] | 6.0 | 448[cf] | 5.0 |

[a]Least square means are based on 43, 38, and 43 means for LP, MP, and HP treatment groups, respectively in May, and on 38, 37, and 54 means for LP, MP and HP groups, respectively in November (Animals were weighed in groups of 5-12).

[b]Standard error of the least square mean.

[c,d]Means within a row having different superscripts differ P<.01.

[f,g]Means within a column having different superscripts differ P<.01.

Higher body weights observed in November for all three treatment groups are probably associated with factors like compensatory gain, higher forage quality and the advanced stage of pregnancy of cows during that month.

Cow Serum Analyses

Treatment differences ($P<.01$) were observed for all mineral elements studied for each year (table 8), except for zinc in year 2. Blood serum calcium concentration was higher ($P<.01$) in LP group in years 1 and 2. The average calcium concentration for all treatments was greater than the critical level of 8 mg/100ml suggested by Cunha (1964). Mean serum calcium concentrations for all treatments for all years varied from 8.46 to 10.00 mg/100 ml. These values are similar to the values (8.8 - 9.6 mg/100 ml) reported by Kiatoko et al. (1982) in four regions of Florida.

Among treatments within years, highest ($P<.05$) serum magnesium concentrations were found in LP and HP groups for year 1 and the MP group for years 2, and 3. Mean magnesium concentrations below the critical level of 1.8 mg/100ml (Underwood, 1966) were observed in LP (1.75 mg/100 ml) and HP (1.77 mg/100 ml) groups in year 2. Adequate (> 1.8 mg/100 ml) magnesium concentrations were found for the same general region by Kiatoko et al. (1982) who reported mean plasma magnesium content of 2.3 mg/100 ml. Merkel (1989) reported Charolais cows in North Central Florida having 2.0 mg/100 ml magnesium.

TABLE 8. INFLUENCE OF DIETARY PHOSPHORUS CONCENTRATION ON SERUM MINERAL CONCENTRATIONS FOR COWS BY YEAR[a]

| | Ca | Mg | P | Zn | Cu |
|---|---|---|---|---|---|
| | ------mg/100ml------ | | | -----ppm---- | |
| Critical level[b] | 8.00 | 1.80 | 4.50 | .80 | .65 |
| YEAR 1 | | | | | |
| LP | 10.00[d] | 2.16[d] | 4.12[e] | .90[d] | .76[e] |
| MP | 9.54[e] | 1.94[e] | 5.37[d] | .97[d] | .89[d] |
| HP | 8.68[f] | 2.12[d] | 3.90[e] | .73[e] | .97[d] |
| S.E.[c] | .11 | .04 | .11 | .04 | .03 |
| YEAR 2 | | | | | |
| LP | 9.55[d] | 1.75[e] | 4.88[d] | .86 | .93[e] |
| MP | 8.46[f] | 2.27[d] | 3.42[f] | .76 | 1.12[d] |
| HP | 9.04[e] | 1.77[e] | 4.27[e] | .80 | .83[e] |
| S.E. | .08 | .03 | .11 | .06 | .06 |
| YEAR 3 | | | | | |
| LP | 9.41[d] | 2.07[e] | 4.58[d] | .63[d] | .89[e] |
| MP | 9.16[e] | 2.26[d] | 3.21[f] | .44[f] | .83[e] |
| HP | 9.47[d] | 1.97[e] | 3.75[e] | .54[e] | 1.15[d] |
| S.E. | .10 | .04 | .16 | .03 | .07 |

[a]Least square means are based on 92 samples per treatment per year.

[b]McDowell and Conrad, 1977; NCMN, 1973; Underwood, 1966, 1981; Cunha, 1964.

[c]Standard error of the least square means.

[def] Means within a year in the same column having different superscripts differ P<.05.

Mean serum phosphorus concentration in MP group (5.37 mg/100 ml) were higher (P<.01) than LP (4.12 mg/100 ml) and HP (3.90 mg/100 ml) groups during the first year of the experiment. For years 2 and 3, LP group showed highest (P<.01) serum phosphorus concentrations (4.88 and 4.58 mg/100 ml, respectively). Mean serum phosphorus concentration below the critical level of 4.5 mg/100 ml (Underwood, 1966; McDowell, 1985) were found for LP (4.12 mg/100 ml) and HP (3.90 mg/100 ml) groups in year 1, for MP (3.42 mg/100 ml) and HP (4.27 mg/100 ml) groups in year 2, and for MP (3.21 mg/100 ml) and HP (3.75 mg/100 ml) groups in year 3. For the same general region, Kiatoko et al. (1982) reported mean plasma phosphorus values of 6.1 mg/100 ml in the fall and 5.2 mg/100 ml in the winter.

The NCMN (1973) does not recommend the use of serum phosphorus concentration as a practical criterion for assessing phosphorus status of grazing ruminants due to its great variation and the poor understanding of the factors that cause this variation. The factors that may increase blood inorganic phosphorus concentration include water restriction (Rollison and Bredon, 1960), increased storage time or temperature post sampling (Burdin and Howard, 1963), and time of sampling (Perge et al. (1983). Underwood (1981) reported the adequacy of serum phosphorus as a satisfactory criterion in assessing phosphorus status in cattle.

In year 1, zinc concentrations were lower (P<.05) for the HP treatment. No effect (P>.05) of dietary phosphorus content was observed on blood serum zinc concentration in year 2 but differences (P<.05) among treatments were found for year 3. Serum zinc concentration values were all in the normal range of .50-1.20 ppm (Underwood, 1981) except the value (.44 ppm) of MP group in year 3. Merkel (1989) reported serum zinc values of .63 and .91 ppm for March-April and October-November, respectively. In year 1, serum copper values in HP were higher (P<.01) than LP group (.97 vs .76 ppm) and MP and HP had similar (P>.05) copper values. In year 2, MP group exhibited the highest (P<.05) serum copper value while for year 3 the HP group was the highest (P<.05). Mean serum copper values observed were all above the critical level of .65 ppm (McDowell and Conrad, 1977). Approximately similar values for the summer-fall (1.08 ppm) and for the winter-spring (.98 ppm) seasons were reported by McDowell et al. (1989).

Table 9 shows the effect of dietary phosphorus content and sampling date on serum mineral concentrations for years 2 and 3. All serum minerals tested exhibited treatment by sampling date interaction effects (P<.01), except zinc (P>.05).

Serum calcium concentrations in LP and HP treatments were higher (P<.05) in May than in November. Serum magnesium content in LP and MP groups were higher (P<.05) in May than

in November while HP group exhibited higher (P<.05) serum magnesium in November than May.

No sampling date difference (P<.05) was found in LP group for serum phosphorus concentration. Serum phosphorus from MP group collected in November was higher (P<.05) than that collected in May (4.34 vs 2.29 mg per 100 ml). The HP group was just the reverse, serum phosphorus content collected in May was higher (P<.05) than that collected in November (4.37 vs 3.65 mg per 100 ml).

From Florida, Merkel (1989) reported no serum calcium, magnesium and phosphorus concentration differences (P>.05) when comparing sampling dates of March-April and October-November. Kiatoko et al (1982) reported no season (winter vs fall) differences (P>.05) in calcium and phosphorus concentrations, but serum magnesium was higher (P<.01) during the fall than winter (2.6 vs 2.1 mg/100 ml). Shirley et al. (1968) found plasma phosphorus seasonal variation with concentrations higher during fall than in winter.

Serum zinc content collected in May were higher (P<.05) than those collected in November for all treatments. Merkel et al. (1990) reported that serum zinc concentrations were higher (P<.05) in October-November than in March-April. Kiatoko et al.(1982) reported no differences on serum zinc content between summer and winter seasons. All treatment groups had mean serum zinc levels between the range of .50 and 1.20 ppm (Underwood, 1981) except MP group in November.

TABLE 9. INFLUENCE OF DIETARY PHOSPHORUS CONCENTRATION AND SEASON ON SERUM MINERAL CONCENTRATIONS FOR COWS[a]

| Element[b] | | Treatments | | | |
|---|---|---|---|---|---|
| | | LP | MP | HP | SE[c] |
| Ca, mg/100ml | May | $9.74^{df}$ | $8.84^{g}$ | $9.69^{df}$ | 0.09 |
| | Nov. | $9.21^{ef}$ | $8.78^{g}$ | $8.82^{eg}$ | 0.09 |
| Mg, mg/100ml | May | $1.99^{dg}$ | $2.45^{df}$ | $1.70^{eh}$ | 0.03 |
| | Nov. | $1.83^{eg}$ | $2.08^{ef}$ | $2.04^{df}$ | 0.03 |
| P, mg/100ml | May | $4.60^{f}$ | $2.29^{eg}$ | $4.37^{df}$ | 0.12 |
| | Nov. | $4.87^{f}$ | $4.34^{dg}$ | $3.65^{eh}$ | 0.12 |
| Zn, ppm | May | $0.97^{d}$ | $0.72^{d}$ | $0.82^{d}$ | 0.05 |
| | Nov. | $0.51^{e}$ | $0.49^{e}$ | $0.53^{e}$ | 0.05 |
| Cu, ppm | May | $0.86^{g}$ | $1.12^{f}$ | $0.96^{g}$ | 0.06 |
| | Nov. | $0.96^{gf}$ | $0.83^{g}$ | $1.02^{f}$ | 0.06 |

[a]Least square means are based on 46 samples per season, per treatment group per year (two year).
[b]Macrominerals and trace minerals.

[c]Standard error of the least square mean.

[d,e]For each element, means within a column having different superscripts differ P<.05.

[f,g,h]For each element, means within a row having different superscripts differ P<.05.

No difference (P<.05) was found in serum copper concentrations between the two sampling dates for any treatments. Copper concentrations on both sampling dates appeared to be normal compared to critical levels of .65 ppm (NCMN, 1973). In Florida, McDowell et al (1982) also found no differences (P<.01) in plasma copper concentrations between Fall and Winter seasons.

Calf Serum Analyses

Treatment effects (P<.01) were found for all mineral elements in calf serum except for magnesium in year 2 and selenium for all years (Table 10). Mean calcium concentrations in three years varied from 8.14 to 11.35 mg/100 ml. In years 1 and 2, calves from LP showed higher (Table 10) (P<.01) serum calcium content than from HP and MP groups. However, in year 3, calves from LP showed lowest (P<.01) serum calcium concentrations. All treatment groups exhibited mean serum calcium concentrations above the critical level of 8.0 mg/100 ml (Cunha, 1964).

Treatment differences (P<.01) were found in serum magnesium in years 1 and 3, while year 2 exhibited similar (P>.05) concentrations. Magnesium values were all higher than 2.0 mg/100 ml reported by the NCMN ( 1973) as critical. Calf serum phosphorus concentrations were affected (P<.05) by dietary phosphorus content of the dam. In all years, calves from HP treatment exhibited highest (P<.05) serum phosphorus concentrations. Mean calf serum phosphorus concentrations were

TABLE 10. SERUM MINERAL CONCENTRATIONS OF CALVES AS AFFECTED BY DIETARY PHOSPHORUS LEVEL OF THEIR DAMS BY YEAR[a]

| | Ca | Mg | P | Zn | Cu | Se |
|---|---|---|---|---|---|---|
| | ------mg/100ml----- | | | ------ppm-------- | | |
| Critical level[b] | 8.00 | 2.00 | 6.00 | .80 | .65 | .03 |
| YEAR 1 | | | | | | |
| LP | 11.35[d] | 2.06[i] | 7.26[h] | .94[g] | .72[i] | .02 |
| MP | 8.69[f] | 2.41[g] | 7.68[h] | .82[h] | 1.47[g] | .03 |
| HP | 9.79[e] | 2.26[h] | 8.11[g] | .62[i] | .93[h] | .02 |
| S.E.[c] | .16 | .07 | .23 | .07 | .06 | .003 |
| YEAR 2 | | | | | | |
| LP | 10.58[d] | 2.32 | 7.96[h] | 1.37[d] | 1.12[d] | .04 |
| MP | 10.04[e] | 2.28 | 8.01[h] | .95[e] | .69[e] | .03 |
| HP | 10.08[e] | 2.30 | 8.56[g] | 1.26[d] | .48[e] | .03 |
| S.E. | .12 | .07 | .21 | .11 | .11 | .003 |
| YEAR 3 | | | | | | |
| LP | 8.14[e] | 2.64[d] | 3.03[d] | 1.15[e] | .94[f] | .03 |
| MP | 10.33[d] | 2.41[e] | 6.93[e] | 3.31[d] | 2.38[e] | .03 |
| HP | 10.44[d] | 2.25[f] | 8.51[f] | 4.32[d] | 3.72[d] | .04 |
| S.E. | .23 | .05 | .23 | .41 | .29 | .003 |

[a]Least square means are based on the following number of samples:15 for each group in year 1; 12,14,14 for LP, MP, HP groups, respectively in year 2, and 15 for each group in year 3.

[b]McDowell and Conrad, 1977; NCMN, 1973; Underwood, 1966, 1981.

[c]Standard error of least square mean.

[d,e,f]For each year, means within a column having different superscripts differ P<.01.

[g,h,i]For each year, means within a column having different superscripts differ P<.05.

above the critical level of 6.0 mg/100 ml (Underwood, 1981) for calves, except for LP group in year 3. Williams et al.(1990) reported calf serum phosphorus concentrations were not affected by dietary phosphorus content of the dam and values were considered as normal. In the present experiment there was a tendency for the serum phosphorus concentration to increase as the amount of phosphorus supplemented to the dam increased.

Calf serum zinc concentrations were affected ($P<.05$) in all years. Serum zinc concentration of calves were all above the critical level of .50 ppm (Underwood, 1981), except for HP group in year 1. From Florida, Salih et al. (1986) reported no differences ($P>.05$) in calf serum zinc concentrations from supplemented and unsupplemented dams.

Calf serum copper concentrations were affected ($P<.01$) by dietary phosphorus concentration of the dam. Mean serum copper values, except HP in year 2, were above the critical level of .65 ppm (McDowell and Conrad, 1977). Merkel et al.(1990) found levels of .35 to 1.19 ppm serum copper in Charolais calves in Florida. Calf serum selenium content was not affected ($P>.05$) by dietary phosphorus content of the dam. In year 1, serum selenium content below the critical level of .03 ppm (McDowell and Conrad, 1977) were observed in LP (.02) and HP (.02 ppm) groups. In years 2 and 3, serum selenium values were equal or above the critical level. Similar values were reported from Florida by Salih et al. (1986).

Serum Minerals of Open vs Pregnant Cows

The effect of dietary phosphorus content and cow class on serum mineral concentrations for years 2 and 3 of the experiment is shown in Table 11. No interaction effect ($P>.05$) between dietary phosphorus concentration and cow class was observed in serum mineral concentrations except ($P<.01$) for magnesium and zinc.

Mean serum calcium concentration in open and pregnant cows appeared to be similar ($P>.05$) in all treatment groups except in the LP group, mean serum calcium levels of pregnant cows was lower ($P<.05$) than in open cows (9.21 vs 8.37 mg/100 ml).

No differences ($P>.05$) were observed in serum magnesium concentrations among treatments in open cows. However, pregnant cows had higher ($P<.05$) serum magnesium concentrations in MP and HP groups. Open cows exhibited serum magnesium concentrations below those reported as critical (McDowell, 1976).

No treatment differences ($P>.05$) were observed in open cows, while pregnant cows of LP group had higher ($P<.05$) phosphorus concentration than MP and HP groups. Mean serum phosphorus concentrations below the critical level of 4.5 mg/100 ml (McDowell, 1976) were observed for open cows in all treatment groups.

TABLE 11. INFLUENCE OF DIETARY PHOSPHORUS CONCENTRATION AND COW CLASS ON SERUM MINERAL CONCENTRATIONS[a]

| Element[b] | | Treatments LP | MP | HP | SE[c] |
|---|---|---|---|---|---|
| Ca, mg/100ml | Pregnant | 9.21[df] | 8.78[g] | 8.82[g] | .09 |
| | Open | 8.37[e] | 8.31 | 8.63 | .22 |
| Mg, mg/100ml | Pregnant | 1.83[ef] | 2.08[dg] | 2.04[dg] | .03 |
| | Open | 1.98[d] | 1.92[e] | 1.79[e] | .07 |
| P, mg/100ml | Pregnant | 4.87[df] | 4.34[g] | 3.65[h] | .11 |
| | Open | 4.31[e] | 4.26 | 3.97 | .27 |
| Zn, ppm | Pregnant | .51[e] | .49[e] | .53[e] | .02 |
| | Open | .88[df] | .90[df] | .71[dg] | .05 |
| Cu, ppm | Pregnant | .96 | .83[e] | 1.02 | .05 |
| | Open | 1.12 | 1.18[d] | 1.29 | .14 |

[a]Least square means are based on 92 samples for pregnant and 14 samples for open cows per treatment (two year data).

[b]Macrominerals and trace minerals.

[c]Standard error of the least square mean.

[d,e]For each element, means within a column having different superscripts differ P<.05.

[f,g,h]For each element, means within a row having different superscripts differ P<.05.

Serum zinc concentrations were higher in open cows (P.>05) in all treatment groups. Pregnant cows from treatment MP showed serum zinc content (.49 ppm) below the critical level of .50 ppm (Underwood, 1981). No treatment differences (P>.05) were observed on serum copper content in pregnant or open cows. In MP group, open cows had higher (P<.05) serum copper concentration (1.18 ppm) than pregnant cows (.83 ppm).

Liver Mineral Concentrations

Table 12 shows the influence of dietary phosphorus content on liver mineral concentration in cows by year. Dietary phosphorus content had no effect (P>.05) on liver mineral concentrations, except on phosphorus (P<.01) in year 1 and on manganese (P<.01) in year 3. In year 1, mean liver phosphorus concentration was lower (P<.01) in LP treatment. Liver manganese concentrations in year 3 were lowest (P<.01) for the HP treatment.

According to McDowell et al. (1984) liver mineral concentrations are valuable for determining mineral status of cobalt, copper, manganese and selenium. All mean liver mineral concentrations observed in the present study were above the suggested critical levels, except manganese, which was found to be deficient (< 6 ppm) in MP group during year 2 (Eagan, 1975). Individual evaluation of liver samples based on their respective critical levels (Eagan, 1975; McDowell, 1985 and Powell et al, 1964) indicated that 0% of cobalt, 5% of copper, 8% of iron, 13% of manganese, 0% of selenium and 20% of zinc

TABLE 12. INFLUENCE OF DIETARY PHOSPHORUS CONCENTRATIONS ON LIVER MINERAL CONCENTRATION BY YEAR[a]

| | | P % | Fe | Mn | Cu | Co | Zn | Se |
|---|---|---|---|---|---|---|---|---|
| | | | ppm | | | | | |
| Critical level[b] | | | <190 | <6 | <75 | <.05 | <84 | <.25 |
| YEAR 1 | | | | | | | | |
| LP | Mean | .72[e] | 324 | 7.56 | 313 | .63 | 130 | .60 |
| | SE[c] | .01 | 26 | .57 | 21 | .06 | 14 | .10 |
| MP | Mean | .80[d] | 235 | 7.94 | 259 | .77 | 86 | .62 |
| | SE | .02 | 28 | .62 | 23 | .07 | 15 | .10 |
| HP | Mean | .77[d] | 235 | 8.32 | 250 | .65 | 102 | .47 |
| | SE | .02 | 28 | .62 | 23 | .07 | 15 | .11 |
| YEAR 2 | | | | | | | | |
| LP | Mean | .70 | 386 | 6.62 | 222 | .71 | 136 | .47 |
| | SE | .02 | 28 | .62 | 23 | .07 | 15 | .10 |
| MP | Mean | .69 | 341 | 5.49 | 211 | .64 | 117 | .40 |
| | SE | .03 | 74 | .80 | 41 | .06 | 13 | .06 |
| HP | Mean | .65 | 418 | 7.0 | 186 | .77 | 98 | .47 |
| | SE | .04 | 75 | .80 | 41 | .06 | 13 | .06 |
| YEAR 3 | | | | | | | | |
| LP | Mean | .78 | 308 | 8.87[d] | 209 | .79 | 124 | .47 |
| | SE | .01 | 29 | .35 | 38 | .09 | 26 | .05 |
| MP | Mean | .78 | 265 | 8.34[d] | 190 | .57 | 125 | .38 |
| | SE | .01 | 29 | .35 | 38 | .09 | 26 | .06 |
| HP | Mean | .81 | 299 | 7.29[e] | 241 | .82 | 175 | .50 |
| | SE | .01 | 29 | .35 | 38 | .09 | 26 | .06 |

[a]Least square means are based on the following number of samples: 7,6 and 6 for LP, MP and HP, respectively in year 1, and 7 samples for each treatment group for years 2 and 3.

[b]McDowell, 1976; McDowell and Conrad, 1977; McDowell, 1985.

[c]Standard error of least square mean.

[d,e]For each year, means within a column having different superscripts differ P<.01.

were deficient. The generally favorable liver mineral status of these animals could be accounted for by the consumption of minerals in the supplement.

Bone Minerals

No treatment differences (P>.10) were observed for bone macromineral concentrations, percent ash or specific gravity in any of the three years (table 13).

Langlands (1987) considers that the vertebrae and ribs are more sensitive than long bones to changes in calcium and phosphorus status. Mean bone calcium concentrations below the critical level of 24% (Little, 1972) was found in LP and HP groups in year 1, and in all treatments in year 2. Mean bone magnesium values found during the present study were all below the suggested normal values of .67 to .70% (Blaxter and Sharman, 1955). Bone phosphorus values were found to be all normal (>11.5%) based on the suggested critical level (Little, 1972). Ash values were found to be borderline to deficient with respect to the critical level (Little, 1972). Specific gravity ($g/cm^3$) values were all below the critical level (<1.68%). Individual evaluation of bone samples based on the critical level (Little, 1972) indicated that calcium, phosphorus, ash and specific gravity were deficient in 48%, 0%, 50% and 100% of samples, respectively. In general, normal bone phosphorus concentrations indicated that intake of phosphorus by cattle on the three treatments during the three years of the experiment were adequate.

TABLE 13. INFLUENCE OF DIETARY PHOSPHORUS CONCENTRATION ON BONE MINERAL CONTENT, PERCENT ASH AND SPECIFIC GRAVITY (S.G.) BY YEAR[a]

| | | Ca | Mg | P | ASH | S.G.[d] |
|---|---|---|---|---|---|---|
| | | ---------- % ---------- | | | | g/cm$^3$ |
| Critical level[b] | | 24.5 | - | 11.5 | 66.8 | 1.68 |
| YEAR 1 | | | | | | |
| LP | Mean | 22.1 | .20 | 17.6 | 66.4 | 1.40 |
| | SE[c] | 1.8 | .035 | .3 | .3 | .03 |
| MP | Mean | 27.7 | .30 | 16.7 | 67.0 | 1.40 |
| | SE | 2.1 | .037 | .3 | .4 | .03 |
| HP | Mean | 22.5 | .21 | 17.7 | 66.9 | 1.46 |
| | SE | 2.1 | .037 | .3 | .4 | .03 |
| YEAR 2 | | | | | | |
| LP | Mean | 23.9 | .29 | 17.2 | 65.7 | 1.52 |
| | SE | 2.9 | .040 | .3 | .4 | .03 |
| MP | Mean | 20.5 | .22 | 17.1 | 66.0 | 1.53 |
| | SE | 2.9 | .040 | .3 | .4 | .03 |
| HP | Mean | 19.8 | .22 | 17.1 | 66.5 | 1.54 |
| | SE | 2.9 | .04 | .3 | .4 | .03 |
| YEAR 3 | | | | | | |
| LP | Mean | 27.6 | .32 | 17.2 | 66.1 | 1.54 |
| | SE | 2.0 | .038 | .2 | .3 | .02 |
| MP | Mean | 28.8 | .30 | 17.5 | 66.7 | 1.54 |
| | SE | 2.0 | .038 | .2 | .3 | .02 |
| HP | Mean | 27.7 | .30 | 17.0 | 66.4 | 1.50 |
| | SE | 2.0 | .04 | .2 | .06 | .02 |

[a]Least square means are based on the following number of samples: 7,6 and 6 for LP, MP and HP, respectively in year 1, and 7 for each treatment group in years 2 and 3.

[b]Little, 1972.

[c]Standard error of the least square mean.

[d]Specific gravity.

Hair Selenium

Treatment differences (P<.01) were observed in years 1 and 2 and no difference (P>.05) was observed in year 3 (table 14).

In years 1 and 2, hair selenium concentrations were lowest (P<.01) in the HP treatment, with no treatment effect in year 3. McDowell et al. (1982) in the same region observed low (.143 ppm) hair selenium values, however, these were from animals not reciving supplemental selenium. From Canada, Hidiroglou et al. (1965) reported that no white muscle disease was observed in calves born from dams with hair selenium content higher than .250 ppm.

Relationship of Minerals

Considering values of correlation coefficients (r >¦.5¦ at P<.05), no relationship was observed between blood serum and bone mineral concentrations (appendix A table 26); while in bone, only calcium and magnesium were correlated (r=.859).

No correlation coefficients (r>¦.5¦, P<.05) between liver/serum minerals were observed (appendix A table 27). Correlation coefficients between serum calcium and magnesium (r=.512) and serum magnesium and zinc (r=.521) were observed. Significant correlations (r>¦.5¦, P<.05) between liver minerals (appendix A table 28) were observed for phosphorus and iron (r=-.662), phosphorus and manganese (r=.626), manganese and iron (r=-.529) and molybdenum and cobalt. The few or nonexisting correlations (r>¦.5¦, P<.05) of minerals

TABLE 14. INFLUENCE OF DIETARY PHOSPHORUS CONCENTRATIONS ON HAIR SELENIUM CONCENTRATION AS RELATED TO YEARS (ppm)[a]

| | LP | | MP | | HP | |
|---|---|---|---|---|---|---|
| | Mean | SE[b] | Mean | SE | Mean | SE |
| Year 1 | .843[c] | .047 | .829[c] | .051 | .537[d] | .051 |
| Year 2 | .616[c] | .023 | .642[c] | .023 | .481[d] | .023 |
| Year 3 | .618 | .030 | .522 | .030 | .542 | .030 |

[a]Least square means are based on 7, 6 and 6 samples for LP, MP and HP treatment groups, respectively in year 1, and on 7 samples for each group in years 2 and 3.

[b]Standard error of the least square mean.

[c,d]Means within a row having different superscripts differ $P<.01$.

between or within animal tissues demonstrated the problem of finding significant correlations between soil, forage, and animal tissues (Conrad et al., 1980).

## Summary

A three year study was conducted to determine the effect of dietary supplemental phosphorus on performance and mineral status of grazing cattle in a ranch in central Florida.

The LP group had a lower ($P<.05$) pregnancy rate in year 1 when the concentrations of dietary P were 4% (LP), 8% (MP) and 12% (HP). Pregnancy rates were similar ($P>.05$) in years 2 and 3 when dietary P levels were 6% (LP), 8% (MP) and 12% (HP). Treatment effect on body weight was observed only in November with HP group having heavier ($P<.01$) weights. November weights were higher than May weights ($P<.01$) in all groups.

Treatment effect ($P<.05$) on cow serum mineral concentrations of calcium, phosphorus, magnesium and copper in both May and November were observed. Cow serum minerals below the critical value were observed for magnesium, phosphorus zinc. Treatment effect ($P<.05$) on calf serum mineral content was observed for all minerals except selenium. Mineral concentrations below critical levels for calf serum were found for phosphorus, copper zinc and selenium.

Mean serum mineral values between pregnant and open cows differed ($P<.05$) in calcium, magnesium, phosphorus and zinc. Concentrations below the critical value were found for magnesium and phosphorus in open cows.

Mean liver mineral concentrations were similar ($P>.05$) in all treatments and in all years, except for P and Mn. All mineral elements were above the critical values, except Mn in MP group in year 2.

Bone mineral concentrations, percent ash and specific gravity were similar ($P>.10$) for all treatments and years. Phosphorus was adequate in all treatments. Ash was low in LP group in all years and MP group of year 2. Lower ($P<.01$) hair selenium was found in the HP treatment group in years 1 and 2 with all treatments containing above critical values. The percentages of total samples collected with minerals below critical levels (in parentheses) and suggestive of deficiency in serum of cows and calves, respectively, were as follows: calcium (8 mg/dl), 13 and 9; magnesium (2 mg/dl), 43 and 29; P (4.5, 6.0 mg/dl), 56 and 41; zinc (.50 ppm), 20 and 16; copper (.65 ppm), 14 and 16; and selenium (.03 ppm), 0 and 55. In cow liver percentages were as follows: iron (180 ppm) ,8; manganese (6 ppm), 13; copper (75 ppm), 5; cobalt (.05 ppm) 0; zinc (84 ppm), 20; and selenium (.25 ppm), 0. In bone the percentages were as follows: calcium (24.5%), 48; phosphorus (11.5%), 0; ash (66.5), 50; and specific gravity (1.68 $g/cm^3$) 100.

# CHAPTER V
# FORAGE AND SOIL MINERAL CONCENTRATIONS OVER A THREE YEAR PERIOD IN CENTRAL FLORIDA
# I. MACROMINERALS

## Introduction

Grazing livestock have to depend largely upon forage to fulfill their mineral requirements. Forages rarely satisfy all of the needed mineral requirements of grazing livestock (McDowell, 1977). It has been reported that mineral concentrations in both soils and plants affect the mineral status of grazing livestock (Towers and Clark, 1983).

Mineral composition of forage plants is affected by soil-plant factors including pH, drainage, fertilization, forage species, forage maturity and interaction among minerals (Gomide, 1978; Reid and Hovarth, 1980). Soils of subtropical Florida are dominated by Spodosols and Entisols. With exception of a few organic soils, the soils are acid, infertile and sandy in texture (Fiskel and Zelazny, 1972). Florida pastures containing native forages have been reported to be low in dry matter yield and to be deficient in some plant nutrients.

The historical significance of mineral deficiencies and toxicities in the cattle industry in Florida have been

summarized by Cunha et al. (1964) and Becker et al. (1965). The purpose of this study was to evaluate forage and soil macromineral concentrations over a three year period in Central Florida.

## Experimental Procedure

A three year study was conducted at Deseret Ranches in Osceola County, Florida (Central Florida). Three herds of crossbred beef cattle (1/4 to 3/8 Brahman crossed to British Breeds) were assigned randomly to three treatments of different concentrations of phosphorus supplementation. Soil and forage samples were collected twice a year (May and November) for three years (1986-1988). Three composite soil and forage samples from each of the 7 experimental pastures were collected on each sampling date. Approximately 200 ha were assigned to each treatment. Animals grazed year round at a stocking rate of about 1 cow per ha. Pastures were fertilized in the spring of years 1 and 2 with 20-10-10 ($N$-$P_2O_5$-$K_2O$) at a rate of 100 and 125 kh/ha, respectively and with 25-18-0 ($N$-$P_2O_5$-$K_2O$) in year 3 at a rate of 100 kg/ha. Soil samples were collected using stainless-steel soil sampling tube as described by Bahia (1978). Forage samples were taken with a stainless-steel scissors based on cattle grazing patterns in order to obtain a representative sample.

Forage and soil samples were collected at the same month and site. The principal improved forage species that were collected in all pastures was bahiagrass (Paspalum notatum Flugge). To a lesser extent (less than 5% of total), all pastures were associated with native grasses and legumes. A total 126 of both soil and forage samples were collected during the three years of the experiment (21 samples per month). Soil samples were analyzed for calcium, phosphorus, magnesium, sodium, potassium, aluminum, pH and organic matter according to the procedure used by the IFAS extension soil testing laboratory (Rhue and Kidder, 1983). Soil minerals were extracted using Mechlich I extracting solution method (.05 N HCL + .025 N $H_2SO_4$). Soil mineral concentrations were then determined by inductively coupled argon plasma (ICAP) in a Thermo Jarrel-Ash, Model 9000 (Jarrel-Ash Division, 1982).

Forage samples were processed according to methods of Fick et al. (1979) and were analyzed for calcium, potassium, magnesium and sodium by atomic absorption spectrophotometry (Perkin-Elmer Corp., 1980). Reference material (e.g. tomato leaves ) from the National Bureau of Standards (NBS) was included as an internal. Forage crude protein and phosphorus were determined using procedures set forth by Gallaher et al. (1975) and Technicon Industrial Systems (1978). Forage in vitro organic matter digestibility (IVOMD) was determined by a modification of the two stage method (Tilley and Terry, 1963) by Moore and Mott (1974).

Data obtained in the present study were statistically analyzed using a 3 (years) by 2 (seasons) factorial design (Snedecor and Cochran, 1980) using the General Linear Models (GLM) procedure of the SAS System (SAS Institute Inc., 1987).

## Results and discussion

### Soils

Soil macrominerals, organic matter and pH analyses as related to month and year are presented in table 15. Year differences ($P<.05$) were observed in both months for all macromineral concentrations except for sodium. No year differences ($P>.05$) were observed for pH values. Seasonal differences ($P<.05$) were observed only for sodium and pH. No year X season interaction ($P>.05$) was observed.

Higher ($P<.05$) aluminum concentrations were found in year 3 for both months. No monthly differences ($P>.05$) were found for soil aluminum in any year. Since the pH values were around 5.5, soil aluminum did not appear to have an effect on phosphorus uptake by plants (Sanchez, 1981). Year 3 showed higher ($P<.05$) calcium concentrations in May among years, while, in November years 2 and 3 had higher ($P<.05$) calcium concentrations than year 1. Mean soil calcium values were higher than those of 437 ppm (summer-fall) and 405 ppm (winter-spring) reported by Salih (1988) from North Central Florida.

TABLE 15. SOIL MACROMINERAL, ORGANIC MATTER (OM) AND pH CONCENTRATIONS AS RELATED TO SEASON AND YEAR[a]

| Variable | | Year 1 | Year 2 | Year 3 | S.E.[b] |
|---|---|---|---|---|---|
| Al, ppm | May | 19.5[d] | 25.2[d] | 70.5[c] | 14.8 |
| | Nov. | 57.8[dc] | 41.9[d] | 84.0[c] | 14.8 |
| Ca, ppm | May | 718[d] | 860[d] | 1141[c] | 77 |
| | Nov. | 679[d] | 1140[c] | 1244[c] | 77 |
| Mg, ppm | May | 40.6[c] | 91.3[d] | 127.7[d] | 13.9 |
| | Nov. | 54.5[e] | 101.3[d] | 160.7[c] | 13.9 |
| K, ppm | May | 10.3[d] | 25.4[d] | 52.5[c] | 7.2 |
| | Nov. | 11.6[d] | 30.6[d] | 65.1[c] | 7.2 |
| Na, ppm | May | 8.8[g] | 15.1 | 27.7 | 4.9 |
| | Nov. | 40.2[f] | 14.2 | 21.4 | 4.9 |
| P, ppm | May | 5.43[d] | 9.45[d] | 20.64[c] | 2.19 |
| | Nov. | 5.77[d] | 7.48[d] | 13.03[c] | 2.19 |
| OM, % | May | 2.48[d] | 4.35[c] | 3.57[c] | .3 |
| | Nov. | 2.34[d] | 4.15[c] | 3.38[c] | .3 |
| pH, | May | 5.4 | 5.4[g] | 5.2[g] | .1 |
| | Nov. | 5.5 | 5.8[f] | 5.7[f] | .1 |

[a]Least square means are based on the following number of samples: 21 samples per month with 2 months per year for 3 years.

[b]Standard error of the least square mean.

[cde]Means among years for the same month with different superscripts differ P<.05.

[fg]Means between seasons for the same variable with different superscripts differ P<.05.

Among years, mean soil magnesium during May was higher ($P<.05$) in years 2 and 3, while in November year 3 had higher ($P<.05$) soil magnesium. Mean soil magnesium values were all above adequate levels of 9.2 to 21.1 ppm (Breland, 1976). Mean soil magnesium concentrations for four soil orders in Florida varied from 29.6 to 116.9 ppm (Kiatoko et al.,1982). Previous studies in the same ranch (Mooso, 1982) showed soil magnesium values ranging from 36.3 to 79.5 ppm.

Soil potassium in year 3 was higher ($P<.05$) in both May and November. Potassium values were similar ($P>.05$) in years 1 and 2 for both months. Mean potassium concentrations were all below the normal level of 80 ppm (Warncke and Robertson, 1976). These results agree closely with previous studies in Florida. Very low soil potassium values ranging from 18.2 to 46.8 ppm also were reported for the same ranch (Mooso, 1982). Low potassium values were reported from North Central Florida, as Merkel (1989) found a mean of 40.5 ppm potassium content in soils. Low soil potassium values may be due to the high potassium leaching from Florida soils (Gammon, 1957).

Month differences ($P<.05$) were observed in soil sodium concentrations in year 1. Average sodium content for the 3 years in both months was below the critical value of 62 ppm (Rhue and Kidder, 1983). Soil sodium values varied from 10.2 to 22.1 ppm for four regions in Florida (Kiatoko et al., 1982).

Soil phosphorus content was highest (P<.01) in both months for year 3. No season effect (P>.05) on mean soil phosphorus was observed in any of the years. Mean soil phosphorus concentrations were all below the critical level of 17 ppm (Rhue and Kidder, 1983), except in May of year 3. Soil phosphorus concentrations varying from 1.9 to 50.1 ppm were reported by Mooso (1982) from unfertilized pastures for the same ranch. Higher phosphorus values ranging from 14.9 to 78.8 ppm were reported by Kiatoko et al. (1982) in the same general region. Phosphorus deficiency may be caused by fixation of phosphates by iron and aluminum (Dudal, 1977).

Mean soil organic matter concentration varied (P<.05) among years. Higher values (P<.05) were found in year 2 and 3 in both months. Similar values varying from 2.11 to 3.85 ppm were found by Mooso (1982) for the same area.

No differences (P>.05) among years were found for soil pH. Soil pH was highest (P<.05) in November for years 2 and 3. Similar values were reported by Kiatoko et al. (1982) and by Mooso (1982). The pH values were in the range of what is found for soils of subtropical Florida.

Forage

Forage macrominerals, crude protein and IVOMD concentrations for May and November for the three years studied are presented in table 16. Year X season interactions (P<.05) were observed for magnesium and potassium. Calcium concentrations were highest (P<.05) for year 1 for both the

May and November collections. November forages contained higher ($P<.05$) calcium in May in years 1 and 2. Mean forage calcium during May and November were .44% and .37%, respectively, both adequate compared to the NRC (1976) requirement (.30%) for growing heifers and mature cows. These values are in agreement with soil calcium analyses.

No differences ($P>.05$) in forage magnesium concentrations among years were found. However, years 1 and 3 had higher ($P<.05$) magnesium in November. Mean magnesium concentrations were generally adequate. In agreement soil magnesium concentrations were adequate. Kiatoko et al.(1982) reported low mean forage magnesium values (.14%) for the winter season. Acid and highly leached soils resulted in reduced availability and absorption of magnesium to the plants (Reid and Horvath, 1980)

Forage potassium was higher in May than November ($P<.05$) for all years with no year differences ($P>.05$). For all years, mean forage potassium was above the requirement of .60% (NRC, 1984) for May collections but deficient in November. Similar potassium seasonal variation has been reported previously (Kiatoko et al., 1982). In agreement with soil potassium analyses, forage potassium concentrations were low during May.

TABLE 16. FORAGE MACROMINERAL, CRUDE PROTEIN (CP) AND IN VITRO ORGANIC MATTER DIGESTIBILITY (IVOMD) CONCENTRATIONS AS RELATED TO SEASON AND YEAR (DRY BASIS)[a]

| Variable | | Year 1 | Year 2 | Year 3 | S.E.[b] |
|---|---|---|---|---|---|
| Ca, % | May | .48$^{cf}$ | .44$^{df}$ | .41$^{d}$ | .01 |
| | Nov. | .42$^{cg}$ | .33$^{dg}$ | .38$^{c}$ | .01 |
| Mg, % | May | .17$^{g}$ | .22 | .21$^{g}$ | .01 |
| | Nov. | .28$^{f}$ | .20 | .27$^{f}$ | .01 |
| K, % | May | .86$^{f}$ | 1.05$^{f}$ | 1.09$^{f}$ | .05 |
| | Nov. | .58$^{g}$ | .54$^{g}$ | .50$^{g}$ | .05 |
| Na, % | May | .037$^{d}$ | .032$^{d}$ | .049$^{c}$ | .004 |
| | Nov. | .025$^{d}$ | .032$^{d}$ | .053$^{c}$ | .004 |
| P, % | May | .13$^{d}$ | .23$^{cf}$ | .21$^{c}$ | .01 |
| | Nov. | .12$^{d}$ | .16$^{cg}$ | .17$^{c}$ | .01 |
| CP, % | May | 8.3$^{e}$ | 11.9$^{cf}$ | 9.7$^{df}$ | .4 |
| | Nov. | 8.0 | 7.8$^{g}$ | 7.7$^{g}$ | .4 |
| IVOMD, % | May | 50.0$^{f}$ | 52.5$^{f}$ | 52.8$^{f}$ | 1.1 |
| | Nov. | 39.7$^{dg}$ | 41.5$^{cg}$ | 35.6$^{eg}$ | 1.1 |

[a]Least square means are based on 21 samples per month (May, November) for 3 years, except for P,CP and IVOMD which are based on 15 samples per month.

[b]Standard error of the least square means.

[cde]Means among years for the same month with different superscripts differ P<.05.

[fg]Means between months for the same variable with different superscripts differ P<.05.

Forage sodium concentrations for year 3 were higher ($P<.05$) for both May and November, with no seasonal differences observed ($P>.05$). Average sodium levels of .04% for both months in the 3 years were below the critical value of .06% (NRC, 1976; McDowell, 1985). Similar low values of .05% for summer-fall and .02% for winter-spring was reported (Salih et al., 1988). Normal values of .07% to .18% for fall and .07% to .1% for winter season were reported by Kiatoko et al. (1982) for Florida.

Forage phosphorus was higher ($P<.05$) in years 2 and 3 during the May collection. Seasonal difference was observed only in year 2, when forage from May (.23%) had higher ($P<.05$) phosphorus than November (.16%). Although values were higher during May, borderline to deficient mean forage phosphorus concentrations were observed at all collection times (.15-.19%), below the suggested critical level of .25% (McDowell, 1976). Similar low mean forage phosphorus values of .16% (fall season) and .10% (winter season) were observed in Florida (Kiatoko et al., 1982). Salih et al. (1988) found values varying from .20 to .23% during the winter-spring and the summer-fall seasons, respectively. Low forage phosphorus observed is in agreement with low soil phosphorus.

Among years, mean forage protein was higher ($P<.05$) in year 2 during May and no differences ($P>.05$) among years was observed during November. Seasonal differences were observed in years 2 and 3 with higher ($P<.05$) crude protein values in

May than in November. Average forage protein values of 10.0% (May) and 7.8% (November) were above the critical value of 7.0% (Minson, 1971). Kiatoko et al. (1982) also reported normal mean forage protein values of 9.4% and 8.45% for the fall and winter seasons, respectively. On the other hand, Salih (1988) reported values of 6.3% for the summer-fall season and 6.0% for the winter-spring season.

Lower mineral and protein concentrations found in the more mature forages grazed during November agrees with Gomide (1978) who found decreased forage nitrogen, phosphorus and potassium with increasing forage maturity.

In vitro organic matter digestibility percentages varied ($P<.05$) among years only during November. However, seasonal differences ($P<.05$) were observed in all years. Forage IVOMD content was higher ($P<.05$) during May in all years, averaging 51.8% for May and 38.9% for November. From northern Florida, Merkel (1989) reported average forage IVOMD values of 44.6, 43.5, 29.2, 33.1 and 62.0% for October, November, December, January and February, respectively. These values suggest that IVOMD values during the spring season were not limiting the production of the animals (Duble et al., 1971).

A limited number of forage samples (24) were analyzed for sulfur. Average sulfur concentration was .23% (+.06) and values ranged from .16 to 40% (DMB). All forage sulfur concentrations were above the suggested requirement of .10% (NRC, 1984).

Summary

A three year study was conducted to determine macromineral status of forages (bahiagrass) and soils on a ranch in central Florida. Soils and forages were collected twice a year (May and November) for 3 years. Three composite samples from each of 7 experimental pastures were collected each sampling date.

Year differences ($P<.05$) were observed in forage calcium, sodium, phosphorus and protein in both seasons. May showed higher ($P<.05$) forage calcium, potassium, phosphorus, crude protein and IVOMD for some years. Magnesium was higher ($P<.05$) in November. In general, season mean values indicate that forage had higher macromineral concentrations during May. Concentrations below the critical value were observed in magnesium for May of year 1 in potassium for November of all years and in sodium and phosphorus for both seasons of all years.

In general, higher ($P<.05$) concentrations were observed for soil aluminum, calcium, magnesium, potassium, sodium and phosphorus in year 3. Season effects ($P<.05$) were observed only in Na in year 1; and in pH in years 2 and 3.

The percentages of total forage samples collected with macromineral and crude protein concentrations below values regarded as critical (in parentheses) and suggestive of

deficiency were as follow: In forage; calcium (.30%), 21%; magnesium (.18%), 34%; potassium (.60%), 47%; sodium (.06%), 89%; phosphorus (.25%), 85%; and crude protein (7%), 18%. The majority of soils were low to deficient in potassium and phosphorus.

# CHAPTER VI
# FORAGE AND SOIL MINERAL CONCENTRATIONS OVER A THREE YEAR PERIOD IN CENTRAL FLORIDA
# I. TRACE MINERALS

## Introduction

Mineral status of soils and forage influence mineral status of grazing livestock but many other animal factors and mineral interactions also play an important role (Towers and Clark, 1983). Grazing livestock have to depend largely upon forages to fulfill their mineral requirements. Forage can rarely satisfy completely the needs for each mineral (McDowell, 1977). Mineral composition of forage plants is affected by soil-plant factors including pH, drainage, fertilization, forage species, forage maturity and interaction among minerals (Gomide, 1978; Reid and Hovarth, 1980). Soils of subtropical Florida are dominated by Spodosols and Entisols. Most soils in Florida are acid, infertile and sandy in texture (Fiskell and Zelazny, 1972). Native Florida pastures have been reported to be low in dry matter yield and to be deficient in some plant nutrients. From Florida, Becker et al. (1965) reported that nutritional anemia or "salt sick"

disease in cattle was caused by a copper, cobalt and iron deficiency.

The historical significance of mineral deficiencies and toxicities in the Florida cattle industry has been summarized by Cunha et al. (1964) and Becker et al. (1965). The purpose of this study was to evaluate forage and soil trace mineral concentrations over a three year period in Central Florida.

## Experimental Procedure

An experiment was conducted at Deseret Ranches in Florida. Three herds of crossbred beef cattle ( 1/4 to 3/8 Brahman crossed to British Breeds) were assigned to three treatments of different levels of phosphorus supplementation. Pastures were fertilized in the spring with 20-10-10 ($N-P_2O_5-K_2O$) at a rate of 100 kg/ha in year 1 and 125 kg/ha in year 2 and with 25-18-0 ($N-P_2O_5-K_2O$) in year 3 at a rate of 100 kg/ha. Soil and forage samples were collected twice a year (May and November), for three years (1986-1988). Three composite soil and forage samples from each of seven pastures were collected each sampling date. Approximately 200 ha were assigned to each treatment. Animals grazed year round at a stocking rate of about 1 cow per ha. Soil samples were collected using the technique described by Bahia (1978). Forages were collected using stainless-steel scissors and based on cattle grazing patterns in order to obtain representative sample.

Forage and soil samples were collected at the same month and at the same site. The main improved forage species that were collected in all pastures in which the experimental animals grazed was bahiagrass (Paspalum notatum Flugge). To a lesser (less than 5% of total) extent, all pastures were associated with native grasses and legumes. A total of 126 of both forage and soil samples were collected during the three years period (21 samples per month).

Soil samples were analyzed for copper, iron, manganese and zinc according to standardized procedures (Rhue and Kidder, 1983). Minerals were extracted from soil using Mechlich I extracting solution method (.05 N HCL + .025 N $H_2SO_4$). Soil mineral concentrations were then determined by Inductively Couple Argon Plasma (ICAP) in a Thermo Jarrel Ash, Model 9000 (Jarrel-Ash Division, 1982).

Forage samples were processed according to methods of Fick et al. (1979) and were analyzed for copper, iron, manganese and zinc by atomic absorption spectrophotometry (Perkin-Elmer Corp., 1980). Cobalt and molybdenum were determined by flameless atomic absorption spectrophotometry (Perkin-Elmer Corp., 1984) and selenium by a modified fluorometric technique (Whetter and Ullrey, 1878). Sulfur concentration was determined using LECO model S-132 sulfur analyzer, Warrendale, PA. Reference material (e.g. tomato leaves ) from the National Bureau of Standards (NBS) was

included as an internal standard with all forage samples analyzed for trace mineral content.

Data obtained in the present study were statistically analyzed using a 3 (years) by 2 (Seasons) factorial design (Snedecor and Cochran, 1980) using the General Linear Models (GLM) procedure of the SAS System (SAS Institute Inc., 1987).

## Results and Discussion

### Soils

Year differences ($P<.01$) were observed for all soil trace mineral concentrations in both May and November (table 17). Month differences ($P<.05$) were observed only for copper in year 1, with November highest. Month X year interaction ($P<.05$) was observed only for copper.

Among years, year 3 showed highest ($P<.01$) copper concentrations in May. Mean soil copper values below critical level of .3 ppm (Rhue and Kidder, 1983) were observed in May of year 1 and in May and November of year 2. Higher values (.3-.7 ppm) of soil copper were reported (Mooso, 1982) from the same area. Soils with less than .6 ppm of extractable copper are considered deficient for pastures and crops (Horowitz and Dantas, 1973).

Among years, soil iron concentration was higher ($P<.01$) in year 3 during May. No month differences ($P>.05$) were observed in soil iron for any of the years. Mean iron

TABLE 17. SOIL TRACE MINERAL CONCENTRATION AS RELATED TO SEASON AND YEAR[a]

| Variable | Month | Year 1 | Year 2 | Year 3 | S.E.[b] |
|---|---|---|---|---|---|
| Cu, ppm | May | .089[df] | .095[d] | .337[c] | .053 |
| | Nov. | .350[ce] | .128[d] | .354[c] | .053 |
| Fe, ppm | May | 6.09[d] | 5.58[d] | 10.15[c] | 1.34 |
| | Nov. | 5.77[dc] | 3.52[d] | 8.70[c] | 1.34 |
| Mn, ppm | May | .88[d] | 1.82[d] | 3.22[c] | .47 |
| | Nov. | 1.02[d] | 2.67[c] | 3.40[c] | .47 |
| Zn, ppm | May | .70[d] | 1.24[d] | 4.37[c] | .6 |
| | Nov. | .77[d] | 2.01[d] | 4.42[c] | .6 |

[a]Least square means are based on 21 samples per month with 2 months per year for 3 years.

[b]Standard error of the least square mean.

[cd]Means among years for the same month with different superscripts differ P<.01.

[ef]Means between seasons for the same variable with different superscript differ P<.05.

values were generally high compared to the critical level of 2.5 ppm (Viets and Lindsay, 1973) for Florida soils. Higher soil iron values (6 ppm) were reported by Mooso (1982). Merkel (1989) from North Central Florida reported 14.3 ppm as mean iron content in soils.

Among years, higher ($P<.01$) soil manganese was found in year 3 in May. In November, year 3 was higher ($P<.01$) than year 1 but similar ($P>.05$) to year 2. Mean soil manganese values observed were below the critical level of 5 ppm (Rhue and Kidder, 1983). Mooso (1982) also reported low values ranging from .9 to 2.2 ppm manganese in soils of the same area. Even though soil manganese was low it apparently was adequate since forage concentrations of the mineral were adequate (i.e. 39-66 ppm). Manganese availability is affected by soil acidity, with manganese more available for pH values around 4.0 (Leeper, 1977). Also, higher concentrations of organic matter result in increased manganese solubility.

Year 3 had higher ($P<.01$) soil zinc content in both months. Mean soil zinc values below the critical level of 1.5 ppm (Sanchez, 1976) for normal plant growth were found in May and November during year 1 and in May in year 2. Previous studies on the same ranch (Mooso, 1982) showed soil values ranging from .7 to 2.2 ppm of zinc.

Forage

Mean forage trace mineral concentrations for May and November of the three years are presented in table 18. No year

effect (P>.05) was observed on forage trace mineral concentrations except for copper (P<.05), iron (P<.05) and molybdenum (P<01). Month differences (P>.05) were observed for iron, molybdenum and zinc. Year X month interactions (P<.05) was observed in all forage trace mineral concentrations observed.

Mean forage cobalt concentrations were all below the NRC (1984) requirement of .1 ppm. Cobalt concentrations ranging from .09 to .11 ppm in four regions of Florida were reported by McDowell et al. (1982). Low concentrations of cobalt also were reported by Merkel et al.(1990) for the Northern Central region of Florida. There are factors that interfere with cobalt absorption by ruminants. Grace (1983), cited by Mayland et al. (1987), indicated that manganese and iron reduce cobalt absorption. McDowell et al. (1984) reported that with the exception of phosphorus and copper, cobalt deficiency is most often the limiting element for grazing livestock in tropical areas.

Mean forage copper concentrations were lower (P<.05) during May in year 1 and during November in year 2. Forage copper values were all below the critical level of 8 ppm (Jones, 1972). Similar values (3.4-5.2 ppm) were reported by Merkel et al. (1990) from the North Central part of Florida. McDowell et al. (1982) reported higher values varying from 22.3 to 51.5 for the dry and wet season, respectively. High

TABLE 18. FORAGE TRACE MINERAL CONCENTRATIONS AS RELATED TO SEASON AND YEAR (DRY BASIS)[a]

| Variable | Month | Year 1 | Year 2 | Year 3 | S.E.[b] |
|---|---|---|---|---|---|
| Co, ppm | May | .05 | .07 | .03 | .01 |
| | Nov. | .05 | .04 | .07 | .01 |
| Cu, ppm | May | 2.8[d] | 3.6[c] | 4.2[c] | .4 |
| | Nov. | 4.4[c] | 2.9[d] | 4.2[c] | .4 |
| Fe, ppm | May | 42.6[df] | 49.1[cf] | 42.0[dg] | 1.7 |
| | Nov. | 37.3[dg] | 36.6[dg] | 47.6[cf] | 1.7 |
| Mn, ppm | May | 48.4 | 60.2 | 38.6 | 6.2 |
| | Nov. | 54.6 | 55.8 | 66.0 | 6.2 |
| Mo, ppm | May | .42 | .57 | .48[g] | .2 |
| | Nov. | .29[e] | .84[d] | 3.63[cf] | .2 |
| Se, ppm | May | .07 | .05[g] | .06 | .007 |
| | Nov. | .07 | .09[f] | .07 | .007 |
| Zn, ppm | May | 17.7 | 20.6[f] | 22.2[f] | 1.8 |
| | Nov. | 16.6 | 13.8[g] | 11.0[g] | 1.8 |

[a]Least square means are based on 21 samples per month with 2 months per year for 3 years except for Se which are based on 15 samples per month.

[b]Standard error of the least square mean.

[cde]Means among years for the same month with different superscripts differ P<.05.

[fg]Means between months for the same variable with different superscripts differ P<.01.

concentrations of molybdenum and sulfur interfere with copper absorption. A copper:molybdenum ratio in herbage of 2.0 or greater is desirable to avoid molybdenosis (Ward, 1978).

Forage molybdenum concentrations were different ($P<.05$) among years in November but not in May. Month difference was observed only in year 3, with the November collection highest ($P<.01$). Mean molybdenum values were all below the toxic level of 6 ppm suggested by McDowell (1985). Similar values were reported from Florida by McDowell et al. (1982) and Merkel et al. (1990). The critical copper:molybdenum ratio of 2 or less (Ward, 1978) was reached during November in year 3.

Forage iron concentrations varied ($P<.05$) among years in both months. All mean forage iron concentrations observed were below the critical level of 50 ppm (Jones (1972). McDowell et al. (1982) reported mean values ranging from 127 to 130 ppm for the winter and fall seasons, respectively. Similar normal values also were reported by Merkel (1989). Iron deficiency is rare in grazing cattle due to a generally adequate content in forages (McDowell et al., 1984). However, under Florida conditions, iron deficiency in cattle grazing on sandy soils has been reported (Becker et al. 1965).

Forage manganese levels were similar ($P>.05$) among years and between months ($P>.05$). All manganese values except that of May in year 3 were adequate according to the critical value of 40 ppm (McDowell, 1985). Under Florida conditions,

higher concentrations of manganese in forage were reported by McDowell et al. (1982) and Merkel et al. (1990).

Forage selenium values among years were similar (P>.05) in both months. Month differences were observed only in year 2, with higher (P<.01) concentrations in November. All mean forage selenium values were below the critical level of .2 ppm (NRC, 1984). Similar low values also were reported for the same general area by McDowell et al. (1982) and Merkel et al (1990). In some areas cattle can grow normally on pastures containing .03 ppm of selenium (Mayland et al., 1987)

Forage zinc concentrations were similar (P>.05) among years in both months. Month differences were found only in years 2 and 3 with higher (P<.01) zinc concentration in May. Mean forage zinc concentrations found were below 25 ppm suggested as a critical level (Mayland et al., 1980). Previous studies in the same area (Mooso, 1982) indicate that bahiagrass zinc concentrations vary from 17.3 to 27.6 ppm. Zinc concentrations may be as high as 30 ppm and occasionally higher, but this concentration declines rapidly as plants mature and levels can decrease to less than 15 ppm (Mayland et al. 1987).

## Summary

A three year study was conducted to determine the trace mineral status of forage (bahiagrass) and soils on a ranch in

central Florida. Forage and soil samples were collected twice a year for 3 years (May and November). Three composite samples from each of 7 pastures were collected each sampling date.

Higher ($P<.01$) forage values of copper, manganese, molybdenum and selenium were found in November. Iron and zinc were higher ($P<.01$) in May. In general, higher ($P<.05$) trace elements values were found in year 2. Among forage trace minerals, only manganese and molybdenum were adequate. Concentrations below the critical level were found for forage cobalt, copper, iron, selenium and zinc in both seasons in all years.

All soil trace elements were higher ($P<.01$) in year 3. Only copper was higher ($P<.05$) in November. Concentrations below critical levels were found for soil copper, in both seasons of year 2 and in May of year 1; and for manganese in both seasons in all years.

# CHAPTER VII
# MONTHLY VARIATION OF FORAGE AND SOIL MINERALS IN CENTRAL FLORIDA I. MACROMINERALS

## Introduction

Undernutrition is commonly accepted to be the most important limitation to livestock production in tropical areas (McDowell, 1985). Mineral deficiencies, imbalances and toxicities have long been held responsible for low production among grazing livestock in tropical areas (Miles et al., 1983). Mineral concentrations in both soils and plants affect mineral status of grazing livestock (Towers and Clark, 1983). Subtropical Florida soils are dominated by Spodosols and Entisols. With few exceptions, soils are acid, infertile and sandy in texture (Fiskell and Zelazny, 1972). Native Florida pastures are low in dry matter yield and deficient in some plant nutrients. Becker et al. (1965) reported calcium and phosphorus deficiency in cattle grazing these areas. Phosphorus deficiency is the most widespread and economically important of all the mineral deficiencies affecting grazing livestock (Underwood, 1966; McDowell, 1985).

Historical significance of mineral deficiencies and toxicities in the cattle industry in Florida have been

summarized by Cunha et al. (1964 and Becker et al. (1965). The purpose of this study was to evaluate forage and soil macromineral concentrations on a monthly basis over a two year period in Central Florida.

## Experimental Procedure

Forage and soil samples were collected monthly from January, 1987 through December, 1988. Soil samples were collected using the sampling technique described by Bahia (1978). Three composite soil samples from each of the 7 pastures assigned to the experiment were collected each sampling period.

Forage and soil samples were collected at the same time and site. The principal improved forage specie in all pastures in which the experimental animals grazed was bahiagrass (Paspalum notatum Flugge). To a lesser (less than 5% of total) extent, all pastures were associated with native grasses and legumes. Three composite forage samples were collected for each of the sampling periods from each pasture as indicated for soil sample collections. A total 502 forage and soil samples were collected in the first and second year of the experiment (252 samples per year, 21 samples per pasture per month). Pastures were grazed year round by beef cattle (1/4 to 3/8 Brahman crossed to British Breeds) at a stocking rate of approximately 1 cow per ha. Pastures were fertilized in spring

with 20-10-10 (N-P-K) and in 1987 and with 25-18-0 (N-P-K) at a rate of 100 kg/ha.

Forage samples collected during the experiment were sent to the Nutrition lab at the University of Florida for preparation and analyses. Soils samples, after preparation at the Nutrition Lab, were brought to the IFAS extension soil testing Lab for chemical analyses.

Soil samples were analyzed for calcium, phosphorus, magnesium, sodium, potassium, aluminum, pH and organic matter according to standardized procedures (Rhue and Kidder, 1983). Soil minerals were extracted using Mechlich I extracting solution method (.05 N HCL + .025 N $H_2SO_4$). Soil mineral concentrations were then determined by inductively coupled argon plasma (ICAP) in a Thermo Jarrel-Ash, Model 9000 (Jarrel-Ash Division, 1982).

Forage samples were processed according to methods of Fick et al. (1979) and analyzed for calcium, potassium, magnesium and sodium by atomic absorption spectrophotometry (Perkin-Elmer Corp., 1980). Forage crude protein and phosphorus were determined using procedures set forth by Gallaher et al. (1975) and Technicon Industrial Systems (1978). Forage <u>in vitro</u> organic matter digestibility (IVOMD) was determined by a modification of the two stage method (Tilley and Terry, 1963) by Moore and Mott (1974). Reference material (e.g. tomato leaves ) from the National Bureau of

Standards (NBS) was included as an internal standard with all forage samples analyzed for mineral content.

Data obtained in the present study were statistically analyzed using a completely randomized design and meas were compared using Duncan's multiple range test (Snedecor and Cochran, 1980) using the General Linear Models (GLM) procedure of the SAS System (SAS Institute Inc., 1987).

## Results and Discission

### Soils

Soil aluminum concentrations ranged from 25 to 77 ppm in year 1 and from 24 to 146 ppm in year 2 (table 19). Soil aluminum concentrations were higher ($P<.05$) in August in year 1 and in March in year 2. Mean soil aluminum concentration was higher ($P<.05$) in year 2. Soil aluminum concentrations found in the present study, were low compared to those (227 ppm) reported by Salih et al. (1988). Since the soil pH values were around 5.5, soil aluminum did not appear to have an effect on phosphorus uptake by plants (Sanchez, 1981).

Mean soil calcium contents among months varied from 730 to 1371 ppm in year 1 and from 1000 to 1564 ppm in year 2. Higher soil values were observed in September in year 1 and in August in year 2. All mean soil calcium concentrations were above the critical value of 71 ppm (Breland, 1976). Soil calcium values were higher ($P<.05$) in year 2. Of the total soils samples analyzed, 100% were adequate (>71ppm). Mean

TABLE 19. SOIL MACROMINERAL, ORGANIC MATTER AND PH CONCENTRATIONS BY MONTH AND YEAR (PPM)[1]

| Elem. | Yr | Month | | | | | | | | | | | Year | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Means | SE |
| Al | 1 | $35^{b}$ | $29^{b}$ | $25^{b}$ | $25^{b}$ | $25^{b}$ | $32^{b}$ | $40^{b}$ | $77^{a}$ | $52^{ab}$ | $37^{b}$ | $42^{b}$ | $57^{ab}$ | $40^{i}$ | 2467 |
| | 2 | $45^{b}$ | $24^{b}$ | $146^{a}$ | $102^{ab}$ | $70^{ab}$ | $69^{ab}$ | $72^{ab}$ | $94^{ab}$ | $79^{ab}$ | $49^{b}$ | $84^{ab}$ | $73^{ab}$ | $76^{h}$ | 1821 |
| Ca | 1 | $730^{d}$ | $1219^{ab}$ | $784^{cd}$ | $966^{abc}$ | $860^{bcd}$ | $1078^{abc}$ | $729^{abc}$ | $1185^{a}$ | $1371^{abc}$ | $1041^{abc}$ | $1140^{abc}$ | $1141^{abc}$ | $1020^{i}$ | 3294 |
| | 2 | 1311 | 1148 | 1399 | 1028 | 1142 | 1332 | 1296 | 1564 | 1254 | 1105 | 1244 | 1000 | $1235^{h}$ | 5465 |
| Mg | 1 | $49^{de}$ | $123^{ab}$ | $71^{dc}$ | $133^{a}$ | $91^{bc}$ | $80^{dc}$ | $39^{e}$ | $92^{bc}$ | $88^{c}$ | $79^{dc}$ | $101^{abc}$ | $85^{c}$ | $86^{i}$ | 2439 |
| | 2 | $98^{b}$ | $94^{b}$ | $122^{ab}$ | $84^{b}$ | $128^{ab}$ | $94^{b}$ | $159^{a}$ | $154^{a}$ | $106^{ab}$ | $139^{ab}$ | $161^{a}$ | $133^{ab}$ | $123^{h}$ | 6175 |
| K | 1 | $17^{de}$ | $42^{ab}$ | $26^{bcde}$ | $39^{abc}$ | $25^{bcde}$ | $41^{abc}$ | $11^{c}$ | $24^{cde}$ | $39^{abc}$ | $32^{abcd}$ | $31^{abcd}$ | $43^{e}$ | $31^{i}$ | 557 |
| | 2 | 37 | 36 | 59 | 27 | 52 | 54 | 64 | 59 | 48 | 54 | 65 | 65 | $52^{h}$ | 1009 |
| Na | 1 | $54^{a}$ | $12^{cd}$ | $8^{d}$ | $11^{cd}$ | $15^{bcd}$ | $13^{bcd}$ | $9^{d}$ | $12^{cd}$ | $20^{b}$ | $12^{cd}$ | $14^{bcd}$ | $17^{cd}$ | 16 | 104 |
| | 2 | 12 | 14 | 22 | 16 | 28 | 17 | 20 | 21 | 20 | 13 | 21 | 26 | 19 | 522 |
| P | 1 | $8^{bcd}$ | $11^{ab}$ | $8^{bcd}$ | $10^{abcd}$ | $9^{abcd}$ | $9^{abcd}$ | $6^{d}$ | $9^{abcd}$ | $11^{ab}$ | $11^{abc}$ | $7^{cd}$ | $13^{a}$ | $10^{i}$ | 35 |
| | 2 | $20^{abc}$ | $16^{bc}$ | $39^{a}$ | $11^{c}$ | $21^{abc}$ | $22^{abc}$ | $40^{a}$ | $43^{a}$ | $37^{ab}$ | $13^{c}$ | $13^{c}$ | $9^{c}$ | $23^{h}$ | 1094 |
| OM | 1 | $2.4^{cb}$ | $4.7^{a}$ | $4.2^{a}$ | $4.5^{a}$ | $4.3^{a}$ | $4.3^{a}$ | $2.1^{c}$ | $4.3^{a}$ | $3.6^{ab}$ | $3.6^{ab}$ | $4.1^{a}$ | $4.3^{a}$ | 3.9 | 3.5 |
| | 2 | $4.0^{abcd}$ | $3.6^{bcde}$ | $4.3^{abc}$ | $2.3^{e}$ | $3.6^{bcde}$ | $4.1^{abcd}$ | $4.3^{abc}$ | $5.1^{a}$ | $4.6^{ab}$ | $3.2^{cde}$ | $3.4^{bcde}$ | $2.7^{de}$ | 3.8 | 3.7 |
| pH | 1 | $5.4^{bc}$ | $5.6^{a}$ | $5.2^{a}$ | $5.3^{a}$ | $5.4^{a}$ | $5.4^{a}$ | $5.4^{c}$ | $5.7^{a}$ | $5.8^{ab}$ | $5.7^{ab}$ | $5.7^{a}$ | $5.7^{a}$ | $5.5^{i}$ | .25 |
| | 2 | $5.8^{ab}$ | $5.5^{cd}$ | $5.7^{abc}$ | $5.6^{abc}$ | $5.2^{d}$ | $5.5^{bc}$ | $5.7^{abc}$ | $5.8^{abc}$ | $5.9^{a}$ | $5.7^{abc}$ | $5.7^{abc}$ | $7.8^{ab}$ | $5.7^{h}$ | .17 |

[1]Means are based on 21 samples per month

[a,b,c,d,e,f,g]For each element, means within a row having different superscripts differ (P<.05).

[h,i]For each element, means between years with different superscripts differ (P<.05).

soil calcium values were higher than those of 403.5 ppm reported by Salih et al. (1988) and those of 455.6 ppm reported by Merkel (1989) from North Central Florida.

Mean soil magnesium varied from 39 to 133 ppm in year 1 and from 84 to 161 in year 2. Magnesium content in soils during April was higher ($P<.01$) in year 1 and during July, August and November in year 2. Lower magnesium values were found during July in year 1 and during January, February and April in year 2. Mean soil magnesium values were higher ($P<.01$) in year 2 than in year 1. Of all soils analyzed, none were deficient, all were above the normal range of 9.2 to 21.1 ppm reported by Breland (1976). Mean soil magnesium concentrations for four soil orders in Florida were reported to vary from 29.6 to 116.9 ppm (Kiatoko et al, 1982). Soil magnesium values from previous studies in the same ranch (Mooso, 1982) varied from 36.3 to 79.5 ppm.

Mean soil potassium varied from 11 to 43 ppm in year 1 and from 27 to 65 ppm in year 2. Soil potassium was higher ($P<.05$) in December of year 1. Potassium did not vary ($P>.05$) among months in year 2. Year 2 showed higher ($P<.01$) mean soil potassium values. All mean potassium concentrations were below 80 ppm, suggested by Robertson (1976) as normal. These results agree closely with previous studies in Florida. Very low potassium values (18.2 ppm) also were reported for the same ranch by Mooso (1982). Low potassium concentrations, mean of 40.5 ppm, were reported from North Central Florida (Merkel,

1989). Low soil potassium values may be due to high potassium leaching in Florida soils (Gammon, 1957).

Sodium content of soils varied from 8 to 54 ppm in year 1 and from 12 to 28 ppm in year 2. Higher ($P<.05$) sodium values were found in January of year 1, with no differences in year 2. Mean sodium values were similar ($P>.05$) between years. Soil sodium values were all below the critical value of 62 ppm (Rhue and Kidder, 1983). Ninety-six percent of all soils were deficient in sodium (<62 ppm). Similar values (16.3 ppm) for soil sodium content were reported from Florida by Salih et al. (1988). Soil sodium values varying from 10.2 to 22.1 ppm for four regions in Florida were reported also by Kiatoko et al. (1982).

Mean soil phosphorus concentrations varied from 6 to 13 ppm in year 1 and from 9 to 43 ppm in year 2. Lower ($P<.01$) phosphorus values were in July in year 1 and in April, October, November and December in year 2. Soil phosphorus concentrations were higher ($P<.05$) in year 2. Mean soil phosphorus concentrations were all below the critical level of 17 ppm (Rhue and Kidder, 1983) for year 1, but were above this critical level in 7 months of year 2. For all soil analyzed, 82% were low (< 17 ppm) in phosphorus. Soil phosphorus values varying from 1.9 to 50.1 ppm were reported by Mooso (1982) from unfertilized pastures for the same ranch. Higher phosphorus concentrations ranging from 14.9 to 78.8 ppm were reported by Kiatoko (1982) in the same general region.

Phosphorus deficiency may be caused by fixation of phosphates by iron and aluminum (Dudal, 1977).

Mean soil organic matter (OM) concentration varied among months from 2.1 to 4.7% in year 1 and from 2.3 to 5.1% in year 2. For year 1 the lowest ($P<.05$) soil OM concentrations were found in January and July. In year 2, the highest ($P<.05$) mean OM value was found during August and lowest ($P<.05$) value in April. Mean phosphorus values were similar ($P>.05$) in both years. Similar values varying from 2.11 to 3.85 ppm were found by Mooso (1982) for the same area. However, lower organic matter concentration (1.6%) were found in Florida soils (Salih, 1984). Organic matter is the main source of cation exchange capacity in Florida soils (Fiskell, 1970).

Mean pH values among months varied from 5.2 to 5.8 during year 1 and from 5.2 to 5.9 in year 2. Higher ($P<.01$) pH values were observed during September, October and November in year 1 and in September only for year 2. Similar pH values for Florida were reported by Kiatoko (1982) and by Mooso (1982). Cation exchange capacity increase with increased pH particularly in surface soils (Fiskell and Zelazny, 1972).

Forage

Mean forage macrominerals, crude protein (CP) and *in vitro* organic matter digestibility (IVOMD) concentrations for 12 months in the two years study are presented in table 20. The corresponding graph is shown in appendix B figure 2 and 3. Mean forage calcium concentrations varied from .32 to .44% in

year 1 and from .22 to .45% in year 2. Forage calcium concentrations were higher (P<.05) in February and May in year 1 and in January only in year 2. All mean forage calcium concentrations in year 1 were above the critical level of .30% (NRC, 1984) for these classes of cattle, while in year 2, four months showed concentrations below the critical level. Similar values of forage calcium were reported from four different regions in Florida (Kiatoko et al., 1982). In general, higher (P<.05) forage calcium concentrations were found in year 1 than in year 2.

Mean forage magnesium concentrations varied from .16 to .29% in year 1 and from .12 to .27% in year 2. Lower (P<.05) magnesium concentrations were found in January, March and April in year 1 and in February of year 2. Concentrations below the suggested critical level of .18% (NRC, 1984) were found in January, March and April during year 1 and in 6 of 12 months in year 2 (table 20). Similar low values for Summer-Fall and adequate values for Winter-Spring of forage magnesium was reported by Salih et al. (1988) from the same general region. In general, mean forage magnesium concentrations were similar (P>.05) in both years.

Mean forage potassium concentrations varied from .21 to 1.05% in year 1 and from .33 to 1.28% in year 2. Lower (P<.05) forage potassium values were found in January and February during year 1 and in January in year 2. Mean forage potassium concentrations below critical levels of .60% potassium

TABLE 20. FORAGE MACROMINERAL, CRUDE PROTEIN (CP) AND IN VITRO ORGANIC MATTER DIGESTIBILITY (IVOMD) CONCENTRATIONS BY MONTH AND YEAR (%)[1]

| Elem. | Yr | Month | | | | | | | | | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Means | SE |
| Ca | 1 | .40$^{ab}$ | .43$^{a}$ | .42$^{ab}$ | .37$^{bc}$ | .44$^{a}$ | .39$^{ab}$ | .33$^{c}$ | .37$^{bc}$ | .33$^{c}$ | .32$^{c}$ | .33$^{c}$ | .41$^{a}$ | .38$^{b}$ | .007 |
| | 2 | .45$^{a}$ | .38$^{bc}$ | .34$^{cde}$ | .41$^{bcd}$ | .22$^{ab}$ | .32$^{g}$ | .26$^{de}$ | .29$^{fg}$ | .25$^{ef}$ | .38$^{fg}$ | .40$^{bc}$ | .40$^{ab}$ | .34$^{b}$ | .007 |
| Mg | 1 | .16$^{a}$ | .19$^{d}$ | .17$^{cd}$ | .16$^{cd}$ | .22$^{bc}$ | .21$^{bc}$ | .23$^{ab}$ | .29$^{bc}$ | .23$^{cd}$ | .20$^{ab}$ | .20$^{bc}$ | .18$^{abc}$ | .20 | .005 |
| | 2 | .17$^{cd}$ | .12$^{e}$ | .17$^{cde}$ | .17$^{cde}$ | .21$^{bc}$ | .13$^{de}$ | .26$^{a}$ | .24$^{ab}$ | .26$^{a}$ | .17$^{cd}$ | .27$^{a}$ | .26$^{a}$ | .20 | .005 |
| K | 1 | .40$^{f}$ | .21$^{g}$ | .45$^{ef}$ | .60$^{de}$ | 1.05$^{a}$ | 1.04$^{a}$ | .79$^{c}$ | .85$^{bc}$ | 1.00$^{ab}$ | .53$^{ef}$ | .54$^{ef}$ | .75$^{cd}$ | .68$^{i}$ | .07 |
| | 2 | .33$^{g}$ | .41$^{fg}$ | 1.28$^{a}$ | .61$^{de}$ | 1.09$^{bc}$ | .66$^{de}$ | 1.15$^{ab}$ | .95$^{c}$ | .74$^{d}$ | .48$^{efg}$ | .50$^{efg}$ | .55$^{def}$ | .74$^{h}$ | .08 |
| Na | 1 | .05$^{a}$ | .01$^{d}$ | .02$^{dc}$ | .02$^{dc}$ | .03$^{bc}$ | .03$^{bc}$ | .04$^{ab}$ | .03$^{bc}$ | .02$^{dc}$ | .04$^{ab}$ | .03$^{bc}$ | .03$^{abc}$ | .04$^{h}$ | .000 |
| | 2 | .02$^{fg}$ | .02$^{g}$ | .04$^{bcde}$ | .03$^{de}$ | .05$^{bc}$ | .05$^{bc}$ | .04$^{cde}$ | .03$^{ef}$ | .04$^{bcd}$ | .07$^{a}$ | .05$^{b}$ | .05$^{bc}$ | .03$^{i}$ | .000 |
| P | 1 | .12$^{cd}$ | .12$^{d}$ | .16$^{b}$ | .19$^{b}$ | .23$^{a}$ | .18$^{b}$ | .19$^{b}$ | .16$^{b}$ | .18$^{b}$ | .18$^{b}$ | .16$^{bc}$ | .16$^{b}$ | .17 | .003 |
| | 2 | .14$^{e}$ | .16$^{de}$ | .24$^{a}$ | .15$^{e}$ | .21$^{abc}$ | .19$^{bcd}$ | .24$^{a}$ | .22$^{ab}$ | .22$^{ab}$ | .18$^{bcde}$ | .17$^{cd}$ | .18$^{cde}$ | .19 | .003 |
| CP | 1 | 7.0$^{f}$ | 7.1$^{ef}$ | 9.6$^{b}$ | 9.7$^{b}$ | 11.9$^{a}$ | 8.9$^{bc}$ | 8.6$^{bcd}$ | 7.3$^{def}$ | 8.9$^{bc}$ | 8.4$^{bcde}$ | 7.8$^{cdef}$ | 7.6$^{cdef}$ | 8.6$^{i}$ | 2.9 |
| | 2 | 7.5$^{e}$ | 8.2$^{cd}$ | 16.4$^{a}$ | 9.4$^{bcd}$ | 9.7$^{bcd}$ | 10.4$^{b}$ | 10.1$^{bc}$ | 9.4$^{bcd}$ | 9.0$^{cde}$ | 8.6$^{cde}$ | 7.8$^{e}$ | 8.2$^{de}$ | 9.6$^{h}$ | 3.6 |
| IVOMD | 1 | 33$^{b}$ | 34$^{b}$ | 66$^{a}$ | 45$^{ab}$ | 52$^{ab}$ | 53$^{ab}$ | 48$^{ab}$ | 46$^{ab}$ | 47$^{ab}$ | 41$^{b}$ | 41$^{b}$ | 39$^{b}$ | 46 | 70.2 |
| | 2 | 38$^{g}$ | 43$^{ef}$ | 58$^{a}$ | 49$^{cd}$ | 53$^{bc}$ | 56$^{ab}$ | 52$^{bc}$ | 49$^{cd}$ | 45$^{de}$ | 39$^{fg}$ | 36$^{g}$ | 37$^{g}$ | 46 | 39.1 |

[1]Means are based on 21 samples per month

[a,b,c,d,e,f,g]For each element, means within a row having different superscripts differ (P<.05).

[h,i]For each element, means between years with different superscripts differ (P<.05).

(McDowell and Conrad, 1977) were found in January, February, March, October and November in year 1, and in 5 of 12 months for both years 1 and 2. Low forage potassium concentrations (.46%) in winter and adequate concentrations (1%) in fall have been reported from Florida (Kiatoko et al., 1982). Mean forage potassium concentrations during year 2 was higher ($P<.01$) than in year 1.

Mean forage sodium contents varied from .011 to .046 in year 1 and from .019 to .069% in year 2. Lower ($P<.05$) sodium levels were observed in February of both years 1 and 2. Mean forage sodium values were below the critical level (.06%, NRC, 1984)and all months were low except October of year 2. On this basis, approximately 90% of all forages analyzed were sodium deficient. Similar low concentrations were reported for summer-fall (.05%) and for winter-spring (.02%) by Salih et al. (1988) from Florida. Mean forage sodium concentration was found to be higher ($P<.01$) in year 2 than in year 1.

Mean forage phosphorus contents varied from .12 to .23% in year 1 and from .14 to .24% in year 2. Lower ($P<.05$) phosphorus values were found in February during year 1 and in January and April during year 2. Mean forage phosphorus concentrations below the suggested critical level of .25% (McDowell, 1976) were found in all months in both years. Phosphorus concentrations in Florida pastures have been reported to be low. Becker et al. (1965) reported a decrease in forage phosphorus concentration from .23% in April to .11%

in July. Salih et al. (1988) reported higher forage phosphorus values in summer-fall (.23%) and lower values in winter-spring (.20%). Mean forage phosphorus concentrations in between years were not different (P>.05). From all forages analyzed, 85% were deficient (<.25%) in phosphorus.

Mean forage protein concentrations varied from 7.0 to 11.9% in year 1 and from 7.5 to 16.4% in year 2. Lower (P<.01) protein concentrations were found in January in year 1 and in January and November in year 2. All mean protein values were equal to or above the critical level of 7% (Minson, 1971). Kiatoko et al. (1982) also reported normal mean forage values of 9.4% and 8.4% for the fall and winter seasons, respectively. Of all forage samples analyzed, approximately 18% were deficient (<7%) in protein. The overall mean forage protein concentration was higher (P<.01) in year 2.

Mean forage in vitro organic matter digestibility (IVOMD) contents varied from 33.1 to 66.2% in year 1 and from 35.6 to 57.6% in year 2. Higher values (P<.01) were observed in during March in both years. Lower values were found in the fall-winter months of October through February in year 1; and during November, December and January in year 2. From North Central Florida, Merkel (1989) reported forage IVOMD values varying from 44.6, 43.5, 29.2, 33.1 and 62.0% for October, November, December, January and February, respectively. Mean IVOMD concentrations in both years were similar (P>.05).

Relationship of minerals

Correlation coefficients of macrominerals between soils and forages and minerals in soil and forage are presented in appendix A tables 29, 31 and 32, respectively. Correlation coefficients ($r>|.5|$, $P<.05$) were present between forage potassium and forage crude protein ($r=.557$); and between forage phosphorus and forage crude protein ($r=.554$). Only low, correlations ($r<|.5|$, $P<.05$) were found between forage and soil minerals: magnesium ($r=.205$), potassium ($r=.250$) and phosphorus ($r=.391$). Also negative correlations were found between forage calcium and soil magnesium ($r=-.328$) and between forage calcium and soil potassium ($r=-.249$). Correlations among soil and forage minerals observed in the present study are in agreement with other researchers (McDowell, 1985) who have indicated that mineral correlations among soil, plant and animal tissue are variable among locations, and are often low or nonexistent.

## Summary

A two year study was conducted to determine the macromineral status of cattle grazed forages, mostly bahiagrass, and soils in central Florida. Soils forages samples were collected every month for two years. Three composite samples from each of the 7 experimental pastures were collected every month.

Month differences ($P<.01$) were observed in all forage macrominerals and in CP for both years. No month effect ($P>.05$) was observed in IVOMD level during year 1. Year effects ($P<.05$) were observed in calcium, sodium and CP. Concentrations below the critical level were observed in all macrominerals studied. Higher forage macromineral concentrations were found during spring-summer months.

In general higher ($P<.05$) soil aluminum, calcium, magnesium, phosphorus and OM were observed during fall-winter months, while, sodium was higher in winter. Soil calcium and magnesium were adequate and potassium, sodium and phosphorus were deficient. Year 2 showed higher ($P<.05$) soil macromineral concentrations. Correlation coefficients ($r>|.5|$, $P<.05$) were present between forage potassium and forage crude protein ($r=.557$); and between forage phosphorus and forage crude protein ($r=.554$). Low correlations were found between soil and forage macrominerals. Percentages of total samples with macromineral and crude protein concentrations below critical levels (in parentheses) and suggestive of deficiency were as follow: In forage; Ca (.30 ppm), 21%; magnesium (.18 ppm), 34%; potassium (.60 ppm), 47%; sodium (.06 ppm), 89%; phosphorus (.25 ppm), 85%; and crude protein (7%), 18%. In soils: calcium (71 ppm), 0%; magnesium (30 ppm), 7%; potassium (80 ppm), 90%; and phosphorus (17 ppm), 82%.

# CHAPTER VIII
# MONTHLY VARIATION OF FORAGE AND SOIL MINERALS IN CENTRAL FLORIDA II. TRACE MINERALS

## Introduction

Grazing livestock usually do not receive mineral supplements except common salt and must depend upon forage to supply their mineral requirements (McDowell, 1985). The mineral status of soils and forage influence the mineral status of grazing livestock but many other animal factors and the interaction among minerals also play an important role (Towers and Clark, 1983).

Forage can rarely satisfy completely the needs for each mineral (McDowell, 1977). Mineral composition of forage plants is affected by soil-plant factors including pH, drainage, fertilization, forage species, forage maturity and interaction among minerals (Gomide, 1978; Reid and Hovarth, 1980). Soils of subtropical Florida are dominated by Spodosols and Entisols. With the exception of organic soils, the soils are acid, infertile and sandy in texture (Fiskell and Zelazny, 1972). Florida trace mineral deficiencies have been established for cobalt, copper, iron (Becker et al. 1965) and selenium (Shirley et al., 1966; McDowell et al., 1982).

The objective of this study was to evaluate forage and soil trace mineral concentrations on a monthly basis over a two year period in Central Florida.

## Experimental Procedure

Soil and forage samples were obtained monthly during two years (January, 1987 to December, 1988). Three composite soil samples from each of seven pastures were collected each sampling period. Soil samples were collected using the sampling technique described by Bahia (1978). Forage and soil samples were collected at the same time and at the same site. The main improved forage specie in all pastures in which the experimental animals grazed was bahiagrass (Paspalum notatum Flugge). To a lesser (less than 5% of total) extent, all pastures were associated with native grasses and legumes. Three composite forage samples were collected for each of the sampling periods from each pasture as indicated for soil sample collections.

Pastures were grazed year round by beef cattle (1/4 to 3/8 Brahman crossed to British Breeds) at a stocking rate of approximately 1 cow per ha. Pastures were fertilized in spring of 1987 with 20-10-10 ($N-P_2O_5-K_2O$) at a rate of 125 kg/ha and in 1988 with 25-18-0 ($N-P_2O_5-K_2O$) at a rate of 100 kg/ha. Pastures were not burned during the two years of the experimental period. A total of 502 soil and forage samples

were collected in both years of the experiment (252 samples per year, 21 samples per month).

Soil samples were analyzed for copper, iron, manganese and zinc according to standardized procedures (Rhue and Kidder, 1983). Minerals were extracted from soil using Mechlich I extracting solution method (.05 N HCL + .025 N $H_2SO_4$). Soil mineral concentrations were determined by Inductively Coupled Argon Plasma (ICAP) in a Thermo Jarrel Ash, Model 9000 (Jarrel-Ash Division, 1982).

Forage samples were processed according to methods of Fick et al. (1979) and were analyzed for copper, iron, manganese and zinc by atomic absorption spectrophotometry (Perkin-Elmer Corp., 1980). Cobalt and molybdenum were determined by flameless atomic absorption spectrophotometry (Perkin-Elmer Corp., 1984), and selenium by a modified fluorometric technique (Whetter and Ullrey, 1878). Reference material (e.g. tomato leaves ) from the National Bureau of Standards (NBS) was included as an internal standard with all forage samples analyzed for trace mineral content.

Data obtained in the present study were analyzed statistically using a completely randomized design and mean differences were calculated using Duncan's multiple range test (Snedecor and Cochran, 1980) by the General Linear Models (GLM) procedure of the SAS System (SAS Institute Inc., 1987).

## Results and Discussion

### Soils

Soils trace mineral analyses as related to month and year are presented in table 21. Mean extractable soil copper concentrations were highly variable among months. Values ranged from .07 to .32 ppm in year 1 and from .17 to .60 ppm in year 2. No month differences ($P>.05$) were observed in year 1. January and February showed adequate (>.3 ppm) soil copper levels in year 1 while in year 2, 5 of 12 months were deficient (Viets and Lindsay, 1973). However, adequate values (.3-.7 ppm) of soil copper were reported by Mooso (1982) from the same area. Horowitz and Dantas ,1973) suggest that soils with less than .6 ppm of extractable copper are considered deficient for pastures and crops; based on this, almost all mean values of the present study would be deficient. Of all samples analyzed, 77% were deficient (<.3 ppm).

Mean soil iron concentration among months were similar ($P>.05$) in year 1 and differed ($P<.01$) in year 2. Year 2 had higher ($P<.01$) mean iron than year 1. Mean iron values were generally high compared to the critical level of 2.5 ppm (Viets and Lindsay, 1973) for Florida soils. Adequate soil iron values (6 ppm) were reported also by Mooso (1982) from the same region. Merkel et al. (1990) from North Central Florida reported 14.3 ppm as mean iron content in soils. Of all samples analyzed for iron, 7% were deficient (<2.5 ppm).

TABLE 21. SOIL MICROMINERAL CONCENTRATIONS AS RELATED TO MONTH AND YEAR (PPM)[1]

| Elem. | Yr | Month | | | | | | | | | | | | Year | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Means | SE |
| Cu | 1 | .30 | .82 | .08 | .12 | .09 | .07 | .07 | .11 | .19 | .13 | .13 | .29 | .20[i] | 1.0 |
| | 2 | .49[ab] | .19[cd] | .47[abc] | .17[d] | .34[abcd] | .22[bcd] | .26[bcd] | .46[abc] | .31[bcd] | .23[bcd] | .35[abcd] | .60[a] | .34[h] | 0.1 |
| Fe | 1 | 6.4 | 4.9 | 4.9 | 8.0 | 5.6 | 4.9 | 6.8 | 5.4 | 4.7 | 4.8 | 3.5 | 7.0 | 5.6[i] | 23.7 |
| | 2 | 5.6[dc] | 6.1[bcd] | 7.3[bcd] | 11.9[a] | 10.1[ab] | 7.2[bcd] | 4.2[d] | 6.6[bcd] | 5.7[cd] | 5.4[cd] | 8.7[abc] | 5.1[cd] | 7.0[h] | 34.6 |
| Mn | 1 | 2.0[bc] | 2.9[ab] | 1.6[bc] | 3.4[a] | 1.8[bc] | 1.7[bc] | .9[c] | 2.0[bc] | 2.2[abc] | 2.6[ab] | 2.7[ab] | 1.6[bc] | 2.1[i] | 3.5 |
| | 2 | 2.0 | 1.7 | 4.0 | 3.2 | 3.2 | 1.7 | 2.9 | 3.8 | 2.9 | 3.1 | 3.4 | 3.0 | 2.8[h] | 4.2 |
| Zn | 1 | 1.1[b] | 1.7[b] | 1.6[b] | 4.2[a] | 1.2[b] | 1.6[b] | .8[b] | 1.1[b] | 1.7[b] | 1.6[b] | 2.0[b] | 1.5[b] | 1.7[i] | 7.3 |
| | 2 | 2.0[b] | 1.4[b] | 4.2[b] | 1.6[b] | 4.4[a] | 1.6[b] | 2.9[ab] | 2.6[ab] | 3.1[ab] | 3.6[ab] | 4.4[a] | 3.3[ab] | 2.9[h] | 9.3 |

[1]Means are based on 21 samples per month

[a,b,c,d,e,f,g]For each element, means within a row having different superscripts differ (P<.05).

[h,i]For each element, means between years with different superscripts differ (P<.05).

These results may support the report of McDowell et al. (1984), who indicated that iron deficiency is rare in grazing cattle due to a generally adequate content in soils and forages. However, Becker et al. (1965) reported iron deficiency in cattle grazing on sandy soils in Florida.

Mean soil manganese values differed ($P<.01$) among months in year 1 and no differences ($P>.05$) were found in year 3. Year 2 showed higher ($P<.01$) mean manganese content than year 1. Mean soil manganese concentrations were below the critical value of 5 ppm (Rhue and Kidder, 1983). Of all soil analyzed, 91% were deficient in manganese. Mooso (1982) also reported low soil manganese concentrations (.9 to 2.2 ppm) in soils from this area. Manganese availability is greatly affected by soil pH (Leeper, 1977). In acid soils with a pH around 4.0 manganese is highly available. Also, higher concentrations of organic matter cause an increase in manganese solubility.

Mean extractable soil zinc concentrations varied from .8 to 4.2 ppm in year 1 and from 1.4 to 4.4 ppm in year 2. Month differences ($P<.05$) were found for mean soil zinc in both years. Higher ($P<.01$) mean zinc values were found in year 2. Mean soil zinc concentrations observed during December, January, May, July, and August in year 1; and during February in year 2 were below the critical value of 1.5 ppm (Sanchez, 1976) for normal plant growth. Of all samples analyzed, 53% were deficient in zinc (< 1.5 ppm). McDowell et al. (1982) reported zinc was deficient in 58% of all soil samples from

four regions of Florida. Previous studies in the same ranch (Mooso, 1982) showed zinc values ranging from .7 to 2.2 ppm.

Forage

Mean forage trace mineral concentrations as related to months and years are presented in table 22. The corresponding graphs averaging the two years are shown in appendix B figure 4 and 5.

Mean forage cobalt concentrations varied from .02 to .07 ppm in year 1 and from .034 to .082 ppm in year 2. Forage cobalt concentrations were found to be higher ($P<.01$) during March and May in year 1. In year 2, all mean forage cobalt concentrations were similar ($P>.05$). Mean forage cobalt concentrations were all below the critical level of .1 ppm suggested by NRC (1984). No year differences ($P>.05$) were observed in forage cobalt concentrations. Individual forage concentrations indicated that 93% of samples were low in cobalt (<.1%). Forage cobalt concentrations ranging from .09 to .11 ppm in four regions of Florida were reported (McDowell et al., 1982). There are factors that interfere with the absorption of cobalt by ruminants. McDowell et al. (1984) suggested that with the exception of phosphorus and copper, cobalt deficiency is the most limiting element for grazing livestock in tropical areas.

TABLE 22. FORAGE MICROMINERAL CONCENTRATIONS AS RELATED TO MONTH AND YEAR (PPM)[1]

| Elem. | Yr | Month | | | | | | | | | | | | Year | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Means | SE |
| Co | 1 | .06$^{ab}$ | .04$^{abcd}$ | .07$^{a}$ | .06$^{abc}$ | .07$^{a}$ | .03$^{cd}$ | .03$^{cd}$ | .02$^{d}$ | .06$^{abc}$ | .04$^{abcd}$ | .04$^{cd}$ | .07$^{ab}$ | .05 | .002 |
| | 2 | .05 | .06 | .29 | .04 | .03 | .04 | .04 | .04 | .05 | .06 | .07 | .08 | .07 | .005 |
| Cu | 1 | 2.5 | 2.8 | 2.9 | 2.8 | 3.6 | 3.4 | 2.7 | 3.0 | 3.0 | 2.5 | 2.9 | 3.0 | 3.0 | 1.5 |
| | 2 | 2.4$^{cd}$ | 2.2$^{cd}$ | 4.7$^{a}$ | 1.7$^{d}$ | 4.2$^{a}$ | 3.8$^{ab}$ | 4.2$^{a}$ | 2.9$^{bc}$ | 2.4$^{cd}$ | 2.4$^{cd}$ | 4.2$^{a}$ | 4.1$^{a}$ | 3.3 | 2.3 |
| Fe | 1 | 49$^{bc}$ | 36$^{fg}$ | 62$^{a}$ | 51$^{b}$ | 49$^{bc}$ | 38$^{efg}$ | 44$^{cde}$ | 40$^{def}$ | 38$^{efg}$ | 32$^{g}$ | 36$^{fg}$ | 46$^{bcd}$ | 43 | 100 |
| | 2 | 48$^{b}$ | 47$^{b}$ | 58$^{a}$ | 46$^{bc}$ | 42$^{bcd}$ | 45$^{bcd}$ | 47$^{b}$ | 38$^{d}$ | 38$^{d}$ | 39$^{cd}$ | 47$^{b}$ | 47$^{b}$ | 45 | 102 |
| Mn | 1 | 47$^{cd}$ | 70$^{b}$ | 98$^{a}$ | 60$^{bc}$ | 60$^{bc}$ | 40$^{cd}$ | 42$^{cd}$ | 35$^{d}$ | 43$^{cd}$ | 49$^{bcd}$ | 56$^{bcd}$ | 63$^{cd}$ | 55 | 1049 |
| | 2 | 76$^{a}$ | 76$^{a}$ | 76$^{a}$ | 57$^{abc}$ | 39$^{cde}$ | 31$^{cde}$ | 39$^{cde}$ | 23$^{e}$ | 32$^{de}$ | 50$^{bcd}$ | 66$^{ab}$ | 65$^{ab}$ | 52 | 1035 |
| Mo | 1 | 1.4$^{a}$ | 1.4$^{a}$ | 1.3$^{a}$ | .4$^{c}$ | .6$^{bc}$ | .7$^{bc}$ | .7$^{bc}$ | .5$^{bc}$ | .7$^{bc}$ | .6$^{bc}$ | .8$^{b}$ | .8$^{b}$ | 82 | .28 |
| | 2 | 1.1$^{c}$ | .5$^{d}$ | .4$^{d}$ | .8$^{cd}$ | .5$^{d}$ | .6$^{cd}$ | .7$^{cd}$ | .4$^{d}$ | .3$^{d}$ | .6$^{cd}$ | 3.6$^{a}$ | 2.2$^{b}$ | 97 | .63 |
| Se | 1 | .09$^{a}$ | .09$^{a}$ | .09$^{a}$ | .07$^{abc}$ | .05$^{cd}$ | .04$^{d}$ | .06$^{bcd}$ | .05$^{cd}$ | .05$^{cd}$ | .07$^{abc}$ | .09$^{a}$ | .06$^{ab}$ | .07 | .001 |
| | 2 | .08$^{b}$ | .08$^{bc}$ | .06$^{bcd}$ | .11$^{a}$ | .06$^{bcd}$ | .07$^{bcd}$ | .06$^{bcd}$ | .04$^{d}$ | .05$^{cd}$ | .06$^{bcd}$ | .07$^{bcd}$ | .07$^{bcd}$ | .07 | .001 |
| Zn | 1 | 19$^{bcd}$ | 21$^{bc}$ | 29$^{a}$ | 21$^{b}$ | 21$^{bc}$ | 21$^{bc}$ | 20$^{bcd}$ | 14$^{cde}$ | 20$^{bcd}$ | 12$^{e}$ | 14$^{de}$ | 17$^{bcde}$ | 19 | 91 |
| | 2 | 18$^{cdef}$ | 15$^{def}$ | 26$^{a}$ | 13$^{ef}$ | 22$^{abc}$ | 24$^{ab}$ | 20$^{bcd}$ | 15$^{def}$ | 15$^{def}$ | 17$^{cdef}$ | 11$^{f}$ | 17$^{cde}$ | 18 | 78 |

[1]Means are based on 21 samples per month

[a,b,c,d,e,f,g]For each element, means within a row having different superscripts differ (P<.05).

[h,i]For each element, means between years with different superscripts differ (P<.05).

Forage copper concentrations varied from 2.5 to 3.6 ppm in year 1 and from 1.7 to 4.7 ppm in year 2. No differences ($P>.10$) in forage copper values were observed in year 1. Higher ($P<.05$) copper values were observed in May, March, July, November and December in year 2. Mean forage copper values were similar ($P>.05$) in both years. Forage copper concentrations were below the critical value of 8 ppm (Jones, 1972). Copper was deficient in 98% of all forage samples analyzed. Similar values (3.4-5.2 ppm) were reported by Merkel (1989) from the North Central part of Florida. McDowell et al. (1982) reported higher values varying from 22.3 to 51.5 for the winter and fall season, respectively of four regions of Florida. High concentrations of molybdenum and sulfur interfere with copper absorption. A copper:molybdenum ratio in herbage of 2.0 or greater is desirable to avoid molybdenosis (Ward, 1978).

Mean forage molybdenum concentrations varied from .39 to 1.42 ppm in year 1 and from .32 to 3.63 ppm in year 2. Higher ($P<.01$) molybdenum values were observed during the fall and winter months of November through March in year 1 and during the fall and winter months of November through January in year 2. Overall mean molybdenum values were similar ($P>.05$) in both years. Mean molybdenum values were all below the toxic level of 6 ppm which can be detrimental to copper metabolism (McDowell et al. 1985). Of all analyzed samples, all were below this toxic level (>6 ppm). Similar values of forage

molybdenum were reported from Florida by McDowell et al. (1982) and Merkel et al. (1990). However, molybdenum values in January in year 1 and in November and December in year 2 were quite high approaching the critical copper:molybdenum ratio in forages of 2:1 or less (Ward, 1978), which would indicate the occurrence of molybdenosis

Forage iron concentrations varied from 11.7 to 29.0 ppm in year 1 and from 38.2 to 58.2 ppm during year 2. Lower ($P<.01$) forage iron were found in October in year 1 and in August and September in year 2. Similar ($P>.05$) forage iron values were found between years. Higher forage iron concentrations were found during March in both years. All mean forage iron values observed were below the critical level of 50 ppm (Jones, 1972), except those of March and April in year 1 and of March in year 2. Of all forages analyzed, 75% were low to deficient in iron as suggested by the NRC (1984) requirement for beef cattle (50 ppm). McDowell et al. (1982) reported mean values ranging from 127 to 130 ppm for the winter and fall seasons, respectively. The generally low forage iron found is in disagreement with the normal soil values found. However, under Florida conditions, iron deficiency in grazing cattle grazing on sandy soils has been reported (Becker et al. 1965).

Mean forage manganese values ranged from 34.7 to 96.7 in year 1 and from 22.7 to 76.3 in year 2. Forage manganese concentrations were higher ($P<.05$) during March in year 1 and

during January, February and March in year 2. Overall mean manganese values in both years were similar (P>.05) and were generally above the requirements of 40 ppm (NRC, 1984). Mean forage manganese values 40 ppm were found during May and August in year 1 and during the spring and summer months of May through September in year 2. Of all forage samples analyzed, 41% were low (<40 ppm) in manganese. Under Florida conditions, higher concentrations of manganese in forage were reported by McDowell et al. (1982) and Merkel et al. (1990).

Mean forage selenium values among months varied from .041 to .094 ppm in year 1 and from .044 to .114 ppm in year 2. Higher selenium values were found in the fall and winter months of November through March in year 1 and during January and April in year 2. There were no differences (P>.05) in mean selenium values between years. All mean forage selenium values were below the critical value of .2 ppm (NRC, 1984). Of all forages analyzed, 98% were deficient in selenium (<.2 ppm). Similar low values were reported also for the same general area by McDowell et al. (1989) and Shirley et al (1966). However, Mayland (1987) stated that in some areas cattle can grow normally on pastures containing .03 ppm of selenium and Pope et al. (1979) indicated that increasing the concentration of sulfur in the forage has a detrimental effect on selenium availability to the animal.

Mean forage zinc concentrations varied from 11.6 to 29.0 ppm in year 1 and from 11.0 to 26.3 ppm in year 2. Lowest

values ($P<.05$) were observed during October and January in year 1 and during November in year 2. Overall mean forage zinc between years were similar ($P>.05$). All mean forage zinc concentrations were below the critical value of 25 ppm (Mayland et al., 1980), except those of March in both years. Of all forage analyzed, 84% were deficient in zinc. Forage zinc concentration varied from 21 ppm in the summer-fall to 28 ppm in the winter-spring seasons in Florida (McDowell et al., 1989). Zinc concentrations may be as high as 30 ppm and occasionally higher, but this concentration declines rapidly as plants mature and levels can decrease to less than 15 ppm (Mayland, 1987).

Relationship of minerals

Correlation coefficients of trace minerals between soils and forage and minerals in soil and forage are presented in appendix A tables 30, 31 and 32, respectively.

Correlation coefficients ($r>|.5|$, $P<.05$) were present between soil copper and soil manganese ($r=.547$) and forage selenium and soil copper ($r=.936$). Low correlations ($r<|.5|$, $P<.05$) were found between soil and forage iron ($r=.072$), manganese ($r=-.039$), copper ($r=-.051$) and zinc ($r=.173$). The few low and nonexistent correlations ($r>|.5|$, $P<.05$) found indicated the problem of finding significant correlations between soil and forage minerals (Conrad et al., 1980).

## Summary

A two year study was conducted to determine the trace mineral status of cattle grazing forages (bahiagrass) and soils on a ranch in central Florida. Forage and soil samples were collected every month for two years. Three composite samples from each of 7 experimental pastures were collected every month.

Month effect ($P<.05$) on soil trace mineral concentrations were observed in manganese and zinc in years 1 and 2, and in copper and iron only in year 2. All soil trace minerals studied showed higher ($P.<05$) concentrations in year 2. Month differences ($P<.05$) in forage trace mineral concentrations were found in cobalt, copper, iron, manganese, molybdenum, selenium and zinc. The majority of forage trace minerals were higher in spring-summer months. Year means were similar ($P>.05$) in forage trace mineral concentrations. Few and low correlation coefficients were observed between and within soil and forage trace minerals concentrations. Percentages of total forage collected with trace minerals below critical values (in parentheses) and suggestive of deficiency were as follows: In forage; Co (.1 ppm), 93%; Cu (8 ppm), 98%; Fe (50 ppm), 75%; Mn (40 ppm),41%; Mo (>6 ppm), 0%; Se (.2 ppm) 98%; and Zn (25 ppm), 84%: In soil; Cu (.3 ppm), 77%; Fe (2.5 ppm), 7%; Mn (5 ppm), 91% and Zn (1.5 ppm), 53%.

# CHAPTER IX
# SUMMARY AND CONCLUSIONS

A three year experiment was conducted at Deseret Ranches in Osceola County, Florida (Central Florida) in order to determine the effect of different supplemental phosphorus concentrations on performance of breeding beef cows and to evaluate the mineral status on the basis of forage, soils and animal tissue analyses.

Three herds of crossbred beef cattle were assigned randomly to three treatment groups. Each group was fed with a complete mineral supplement containing different concentrations of phosphorus [LP = 4%P (6%P), MP = 8%P, HP = 12%P]. Because of low calving percentages observed in year 1 in LP group, the phosphorus content was changed from 4 to 6%. Energy and protein supplements were provided during winter (December to March). Pregnancy of cows was determined once a year (November) while body weights of cows were recorded twice a year (May and November). Blood samples from cows (50 samples from each group) were collected in May and November and from calves (15 samples from each group) in May. Bone biopsy, liver biopsy and hair samples (6-7 samples from each group) were collected in November. Forage and soil samples were collected twice in year 1 (May and November), then in years 2 and 3

forage and soil samples were collected every month. Three composite samples of forages and soils from seven pastures were collected each sampling date.

Serum samples were analyzed for calcium, copper, magnesium, phosphorus, selenium and zinc. Liver was analyzed for copper, cobalt, iron, manganese, molybdenum, phosphorus, selenium and zinc. Bone was analyzed for calcium, magnesium, phosphorus, ash and specific gravity. Hair was analyzed for selenium. Forage samples were analyzed for calcium, copper, cobalt, iron, potassium, magnesium, manganese, molybdenum, sodium, phosphorus, selenium, sulfur, zinc, crude protein and in vitro organic matter digestibility (IVOMD). Soil samples were analyzed for organic matter, pH, aluminum, calcium, copper, iron, potassium, manganese, magnesium, sodium, phosphorus and zinc.

The LP treatment group had a lower ($P<.05$) pregnancy rate in year 1 when the concentrations of dietary P were 4% (LP), 8% (MP) and 12% (HP). Pregnancy rates were similar ($P>.05$) in years 2 and 3 when dietary phosphorus concentrations were 6% (LP), 8% (MP) and 12% (HP). Treatment effect on mean body weight of the 2 years was observed only in November with HP group having higher ($P<.05$) weights. November weights were higher ($P<.01$) in all treatments.

Treatment effects ($P<.05$) on cow serum mineral concentrations were observed in calcium, magnesium, phosphorus, and copper in both seasons. Cow serum mineral

concentrations below the critical value were observed for magnesium in LP group in both seasons and in HP group in May; for phosphorus in MP and HP groups in both seasons; and for zinc in MP group in November.

Treatment effect ($P<.05$) on calf serum mineral content was observed for all minerals except selenium. Concentrations below critical values were found for phosphorus in LP group in year 3, for copper in MP group in year 2, and for selenium in LP and HP groups in year 1.

Mean serum mineral values between pregnant and open cows differ ($P<.05$) in calcium in the LP group; in magnesium in all groups; in phosphorus in the LP group; and in zinc in all groups. Concentrations below the critical level were observed for magnesium in open cows in all treatments and in pregnant cows in the LP group; for phosphorus in open cows on all treatments and in pregnant cows of MP group; and for zinc in pregnant cows of MP group.

Mean liver mineral values were similar ($P>.05$) in all treatments and in all years, except for phosphorus in year 1 and for manganese in year 3. All mineral elements were above the critical values, except manganese. in MP group in year 2.

Bone mineral concentrations, percent ash and specific gravity were similar ($P<.10$) for all treatments and years. Calcium was below the critical value in groups LP and HP of year 1 and in all groups of year 2. Phosphorus was adequate in all treatments. Ash was low in LP group in all years and MP

group of year 2. Lower (P<.01) hair selenium was found in the HP treatment group in years 1 and 2. Correlations (r>|.5|, P<.05) were present between bone calcium and magnesium (r=.859),serum calcium and manganese (r=.512), serum magnesium and zinc (r=.521), liver phosphorus and iron (r=.662), liver phosphorus and manganese (r=.626), and liver manganese and iron (r=.529).

The percentages of total samples collected with minerals below levels regarded as critical (in parentheses) and suggestive of deficiency in serum of cows and calves, respectively, were as follows: calcium (8 mg/dl), 13 and 9; magnesium (2 mg/dl), 43 and 29; phosphorus (4.5, 6.0 mg/dl), 56 and 41; zinc (.5 ppm), 20 and 16; copper (.65 ppm), 14 and 16; and selenium (.03 ppm), 0 and 55. In liver the percentages were as follows: iron (180 ppm) ,8; manganese (6 ppm), 13; copper (75 ppm), 5; cobalt (.05 ppm) 0; zinc (84 ppm), 20; and selenium (.25 ppm), 0. In bone the percentages were as follows: calcium (24.5%), 48; magnesium (.67%), 100; phosphorus (11.5%), 0; ash (66.5), 50; and specific gravity (1.68 $g/cm^3$) 100.

Season effect (May and November) and year effect over a 3 year period on soil and forage macromineral concentrations were studied. Year differences (P<.05) were observed in forage calcium, sodium, phosphorus and protein in both seasons. Forage calcium was higher in year 1, sodium in year 2 and phosphorus, crude protein and IVOMD in year 3. Season effects

($P<.05$) were observed in forage calcium, magnesium, potassium, phosphorus, crude protein and IVOMD. Concentrations below the critical level were observed in magnesium, in May of year 1; in potassium for November of all years; in sodium and phosphorus in both seasons of all years. In general, season mean values indicated that forage had higher macromineral concentrations during May.

Year effects ($P<.05$) were observed in soil aluminum, calcium, magnesium, potassium, phosphorus and organic matter. Season effects ($P<.05$) were observed only in Na in year 1; and in pH in years 2 and 3. In general, higher soil macromineral concentrations were observed in year 3 and pH was higher during November.

Season effect (May and November) and year effect over a 3 year period were also studied on soil and forage trace mineral concentrations. Year effect ($P<.05$) was observed in forage copper, iron, and molybdenum. Season effect ($P<.01$) was observed on forage iron, molybdenum, selenium and zinc concentrations. In general, year 1 showed higher copper, year 2 had higher iron and year 3 higher molybdenum. May had higher iron and zinc values and November had higher molybdenum an selenium. Concentrations below the critical level were found for cobalt, copper, iron, selenium and zinc in both seasons in all years.

Year effects ($P<.01$) on soil micromineral concentrations were observed in iron, copper, manganese and zinc. Season

effect (P<.05) was observed in soil copper. In general, higher soil trace minerals were found in year 3. Concentrations below critical levels were found for soil copper, in both seasons of year 2 and in May of year 1; and for manganese in both seasons in all years. Monthly variation of forage and soil macromineral concentrations over a 2 year period was studied. Month differences (P<.05) were observed in all forage macrominerals and in CP in both years. Year effects (P<.05) were observed in calcium, potassium, sodium and CP. Concentrations below the critical level were observed in all macrominerals studied. Higher forage macromineral concentrations were found during spring-summer months.

Month effects (P<.05) were observed in soil aluminum, calcium, potassium, magnesium, sodium, phosphorus, pH and organic matter during year 1, while in year 2 only magnesium and phosphorus showed month differences (P<.05). Soil potassium, sodium and phosphorus were deficient. Year effects (P<.05) were observed in aluminum, calcium, potassium, magnesium,and phosphorus. Correlation coefficients (r>|.5|, P<.05) were present between forage potassium and forage crude protein (r=.557); and between forage phosphorus and forage crude protein (r=.554). The percentages of total samples collected with macromineral and crude protein concentrations below levels regarded as critical (in parentheses) and suggestive of deficiency were as follows: In forage; calcium (.30 ppm), 21%; magnesium (.18 ppm), 34%; potassium (.60 ppm),

47%; sodium (.06 ppm), 89%; phosphorus (.25 ppm), 85%; and crude protein (7%), 18%. Percentages in soils were as follows: calcium (71 ppm), 0%; magnesium (30 ppm), 7%; potassium (80 ppm), 90%; and phosphorus (17 ppm), 82%.

Effects of months and years over a 2 year period on trace mineral concentrations in soil and forage were also studied. Monthly effects ($P<.05$) on soil trace mineral concentrations were observed in manganese and zinc in years 1 and 2, and in copper and iron only in year 2. The majority of soil trace minerals showed higher concentrations during fall-winter months in year 2. Month differences ($P<.05$) on forage trace mineral concentrations were found in iron, manganese, molybdenum, selenium and zinc in both years; in cobalt in year 1 and in copper in year 2. The majority of forage trace minerals were higher ($P<.05$) in spring-summer months. Only manganese and molybdenum were adequate in forages.

Low correlations were found between soil and forage minerals: iron ($r=.072$), copper ($r=-.051$) and manganese ($r=-.039$). The percentages of total samples collected with trace minerals below levels regarded as critical (in parentheses) and suggestive of deficiency were as follows: In forage; cobalt (.1 ppm), 93%; copper (8 ppm), 98%; iron (50 ppm), 75%; manganese (40 ppm),41%; molybdenum (>6 ppm), 0%; selenium (.2 ppm) 98%; and zinc (25 ppm), 84%: In soil; copper (.3 ppm), 77%; iron (2.5 ppm), 7%; manganese (5 ppm), 91% and zinc (1.5 ppm), 53%.

# APPENDICES

# APPENDIX A

# SUPPLEMENTARY TABLES

TABLE 23. SUMMARY GUIDE TO MINERAL REQUIREMENTS FOR RUMINANTS (DRY BASIS)[a]

| Element | Requirement |
|---|---|
| Calcium, % | .18-.60 |
| Phosphorus, % | .18-.43 |
| Magnesium, % | .04-.18 |
| Potassium, % | .60-.80 |
| Sodium, ppm | .10 |
| Iron, ppm | 10-100 |
| Copper, ppm | 4-10 |
| Cobalt, ppm | .05-.10 |
| Zinc, ppm | 10-50 |
| Manganese, ppm | 20-40 |
| Molybdenum, ppm | .01 or less |

[a]Summarized by McDowell et al. (1978).

TABLE 24. COW MEAN WEIGHTS (Kg) AS RELATED TO TREATMENT, YEAR AND SEASON[a]

| | LP | | MP | | HP | |
|---|---|---|---|---|---|---|
| | WT | #COWS | WT | #COWS | WT | #COWS |
| YEAR 1 | | | | | | |
| Dry | - | 225 | - | 224 | - | 273 |
| Wet | 421.5 | 225 | 431.8 | 224 | 428.8 | 273 |
| YEAR 2 | | | | | | |
| Dry | 395.6 | 189 | 398.7 | 177 | 406.6 | 200 |
| Wet | 411.9 | 181 | 422.5 | 173 | 435.0 | 232 |
| YEAR 3 | | | | | | |
| Dry | 392.1 | 189 | 380.4 | 172 | 380.4 | 216 |
| Wet | 430.8 | 194 | 438.4 | 189 | 456.5 | 198 |

[a]Average weights calculated from cows weighed in groups.

TABLE 25. CALF WEIGHTS AT MARKING AND BRANDING BY SEX AND YEAR (kg)[a]

| TREAT. | LP | | MP | | HP | |
|---|---|---|---|---|---|---|
| SEX | HF'S | ST'S | HF'S | ST'S | HF'S | ST'S |
| YEAR 1 | 111.8 | 115.9 | 112.7 | 127.7 | 109.5 | 113.2 |
| YEAR 2 | 107.3 | 115.9 | 108.2 | 109.5 | 137.7 | 149.1 |
| YEAR 3 | 119.5 | 123.6 | 117.5 | 123.2 | 120.0 | 126.0 |

[a]Average weights calculated from calves weighed in groups.

TABLE 26. OVERALL BONE AND BONE/SERUM MINERAL CORRELATION COEFFICIENTS[a]

| | Bone | | | | |
|---|---|---|---|---|---|
| | Ca | Mg | P | Ash | S.G. |
| Blood serum | | | | | |
| Calcium | .096 | .103 | .048 | .059 | -.398 |
| Magnesium | .180 | .201 | .162 | .060 | -.172 |
| Phosphorus | .225 | .313 | .004 | -.079 | -.013 |
| Zinc | .098 | .184 | .121 | -.022 | .036 |
| Copper | -.014 | .185 | .121 | -.022 | .132 |
| Selenium | -.032 | -.043 | .016 | .043 | -.149 |
| Bone | | | | | |
| Calcium | 1.000 | | | | |
| Magnesium | .859** | 1.000 | | | |
| Phosphorus | .096 | .061 | 1.000 | | |
| Ash | .283 | .111 | .432 | 1.000 | |
| S.G. | .022 | .076 | - .019 | .35 | 1.000 |

[a]Correlation coefficients based on 21, 20 and 20 bone and blood serum samples for LP, MP and HP, respectively.

**($P<0.01$).

TABLE 27. OVERALL SERUM AND LIVER/SERUM MINERAL CORRELATION COEFFICIENTS[a]

| Element | BLOOD SERUM Ca | Mg | P | Zn | Cu | Se |
|---|---|---|---|---|---|---|
| LIVER | | | | | | |
| Phosphorus | .058 | .193 | .121 | .043 | -.080 | .080 |
| Iron | .004 | -.183 | .015 | -.035 | .125 | -.133 |
| Manganese | .023 | .213 | .057 | .009 | -.253 | .092 |
| Copper | .322 | .245 | .004 | -.083 | -.146 | -.063 |
| Cobalt | .129 | .003 | .264 | -.148 | .149 | -.142 |
| Zinc | -.065 | -.239 | .062 | -.191 | .074 | -.226 |
| Molybdenum | -.180 | -.174 | .110 | -.199 | .054 | -.106 |
| Selenium | .140 | .010 | -.199 | -.326 | -.347 | .257 |
| BLOOD SERUM | | | | | | |
| Calcium | 1.000 | | | | | |
| Magnesium | .512** | 1.000 | | | | |
| Phosphorus | .147 | .119 | 1.000 | | | |
| Zinc | .225 | .521** | .086 | 1.000 | | |
| Copper | .125 | .100 | .096 | .179 | 1.000 | |
| Selenium | .226 | .121 | - .109 | - .059 | .179 | 1.000 |

[a]Correlation coefficients for all minerals are based on 61 samples for liver and blood serum, except for liver Se which is based on 28 samples.

**($P<0.01$).

TABLE 28. OVERALL LIVER MINERAL CORRELATION COEFFICIENTS[a]

| | P | Fe | Mn | Cu | Co | Zn | Mo | Se |
|---|---|---|---|---|---|---|---|---|
| P | 1.000 | | | | | | | |
| Fe | -.662** | 1.000 | | | | | | |
| Mn | .626** | -.529** | 1.000 | | | | | |
| Cu | .103 | -.042 | .224 | 1.000 | | | | |
| Co | .162 | .136 | .058 | .161 | 1.000 | | | |
| Zn | .133 | .044 | -.143 | .039 | .263 | 1.000 | | |
| Mo | -.024 | .245 | -.007 | -.073 | .539** | .279 | 1.000 | |
| Se | .206 | -.233 | .329 | .286 | .329 | -.262 | -.002 | 1.000 |

[a]Correlation coefficients based on 61 samples, except for Se which is based on 28 samples.

**(P<0.01).

TABLE 29. SOIL/FORAGE MACROMINERAL CORRELATION COEFFICIENTS[a]

| | FORAGE | | | | | |
|---|---|---|---|---|---|---|
| | Ca | Mg | K | Na | P | CP[b] |
| SOIL | | | | | | |
| Calcium | .051 | -.115 | .087 | .001 | .152 | .031 |
| Magnesium | -.328 | .202 | .036 | .069 | .047 | .151 |
| Potasium | -.249 | -.055 | .250 | .085 | .166 | .204 |
| Sodium | -.117 | .008 | .054 | .131 | -.036 | .028 |
| Phosphorus | -.055 | -.161 | .227 | .047 | .391 | .194 |
| Aluminum | -.154 | .062 | .115 | .098 | .068 | .162 |
| OM[c] | -.101 | -.074 | .060 | .027 | .075 | -.229 |
| PH | .020 | .049 | .111 | .063 | .130 | .056 |

[a]Correlation coefficients for all mineral elements based on 546 samples, except for forage phosphorus and CP which are based on 390.

[b]Crude protein.

[c]Organic matter.

TABLE 30. SOIL/FORAGE TRACE MINERAL CORRELATION COEFFICIENTS[a]

| | SOIL | | | |
|---|---|---|---|---|
| | Fe | Mn | Zn | Cu |
| FORAGE | | | | |
| Iron | .072 | .110 | .044 | .030 |
| Manganese | -.064 | -.039 | -.056 | -.047 |
| Zinc | .055 | .134 | .173 | .026 |
| Copper | -.006 | .108 | .156 | -.051 |
| Cobalt | .014 | -.002 | .012 | .036 |
| Molybdenum | .040 | .094 | .091 | .031 |
| Selenium | -.038 | -.029 | -.036 | .936** |

[a]Correlation coefficients for all elements are based on 454 samples except forage Se, which is based on 389.

**(P<0.01).

TABLE 31. SOIL MINERAL, ORGANIC MATTER AND PH CORRELATION COEFFICIENTS[a]

| | Ca | Mg | K | P | Zn | Cu | Mn | Al | Fe | Na | OM | P[H] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ca | 1.000 | | | | | | | | | | | |
| Mg | .274 | 1.000 | | | | | | | | | | |
| K | .177 | .458 | 1.000 | | | | | | | | | |
| P | .446 | .053 | .236 | 1.000 | | | | | | | | |
| Zn | .187 | .269 | .364 | .259 | 1.000 | | | | | | | |
| Cu | .140 | -.018 | .135 | .205 | .151 | 1.000 | | | | | | |
| Mn | .228 | .391 | .296 | .232 | .547** | .104 | 1.000 | | | | | |
| Al | .083 | .306 | .273 | .141 | .144 | .034 | .349 | 1.000 | | | | |
| Fe | .097 | .119 | .209 | .171 | .428 | .244 | .239 | .381 | 1.000 | | | |
| Na | .062 | .145 | .341 | .117 | .085 | .082 | -.004 | .163 | .227 | 1.000 | | |

TABLE 31. CONTINUED

| | Ca | Mg | K | P | Zn | Cu | Mn | Al | Fe | Na | OM | $P^H$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OM[b] | .267 | .304 | .280 | .214 | .011 | .003 | -.080 | .119 | .129 | .207 | 1.000 | |
| $P^H$ | .392 | .192 | .087 | .121 | .088 | .051 | .243 | .131 | -.087 | -.074 | -.012 | 1.000 |

[a]Correlation coefficients based on 546 samples for all mineral elements

[b]Organic matter.

**(P<0.01).

TABLE 32. FORAGE MINERALS, CRUDE PROTEIN AND IVOMD CORRELATION COEFFICIENTS[a]

| | Ca | Mg | K | Na | P | Fe | Mn | Zn | Cu | Co | Mo | Se | CP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ca | 1.000 | | | | | | | | | | | | |
| Mg | .031 | 1.000 | | | | | | | | | | | |
| K | -.028 | .056 | 1.000 | | | | | | | | | | |
| Na | -.268 | .000 | .062 | 1.000 | | | | | | | | | |
| P | -.123 | .145 | -.074 | .114 | 1.000 | | | | | | | | |
| Fe | .261 | -.056 | .193 | .035 | .041 | 1.000 | | | | | | | |
| Mn | .146 | .071 | -.145 | -.088 | -.038 | .157 | 1.000 | | | | | | |
| Zn | .172 | -.054 | .312 | -.110 | -.073 | .394 | .219 | 1.000 | | | | | |
| Cu | .068 | .164 | .352 | .024 | -.090 | .180 | .063 | .249 | 1.000 | | | | |
| Co | -.002 | -.004 | .023 | .047 | .127 | .184 | .167 | .125 | -.011 | 1.000 | | | |
| Mo | .099 | .133 | -.197 | .125 | -.102 | .156 | .069 | -.027 | .051 | -.012 | 1.000 | | |

TABLE 32. CONTINUED

| | Ca | Mg | K | Na | P | Fe | Mn | Zn | Cu | Co | Mo | Se | CP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Se | .119 | -.143 | -.248 | -.118 | -.214 | .132 | .148 | .000 | -.077 | -.030 | .115 | 1.000 | |
| CP[b] | -.072 | -.035 | .557** | .093 | .554** | .336 | .036 | .336 | .282 | .112 | -.156 | -.103 | 1.000 |

[a]Correlation coefficients for all elements based on 544 samples except for P, CP and Se which are based on 388.

[b]Crude protein.

**P<.01.

# APPENDIX B

# FIGURES

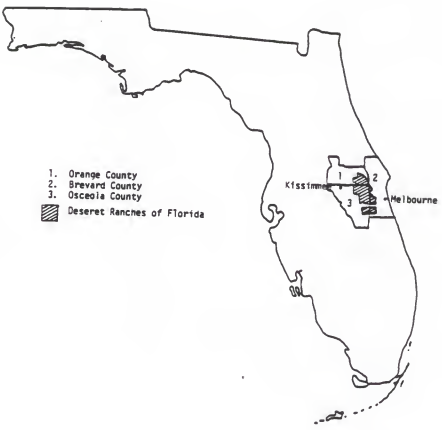


Fig. 1. The location of Deseret Ranches of Florida with respect to Kissimmee and Melbourne, Florida.

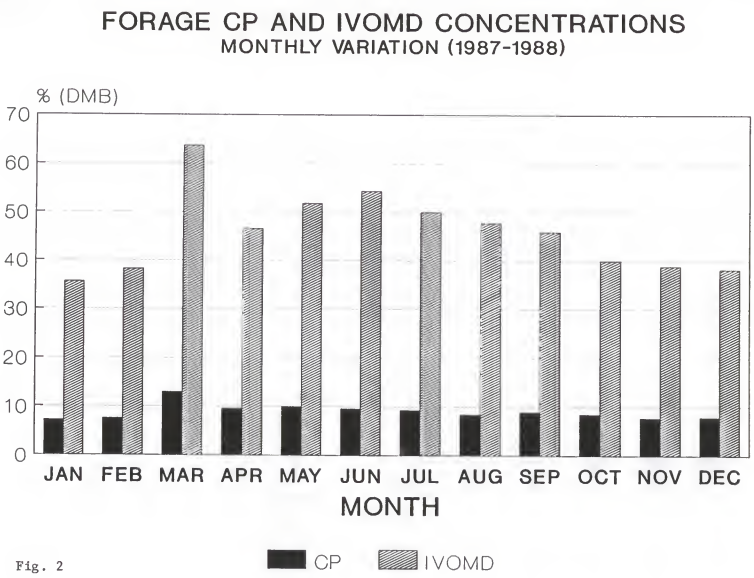
FORAGE CP AND IVOMD CONCENTRATIONS
MONTHLY VARIATION (1987-1988)
% (DMB)
70
60
50
40
30
20
10
0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
MONTH
CP
IVOMD

Fig. 2

# MACROMINERAL CONCENTRATION IN FORAGE
# MONTHLY VARIATION (1987-1988)

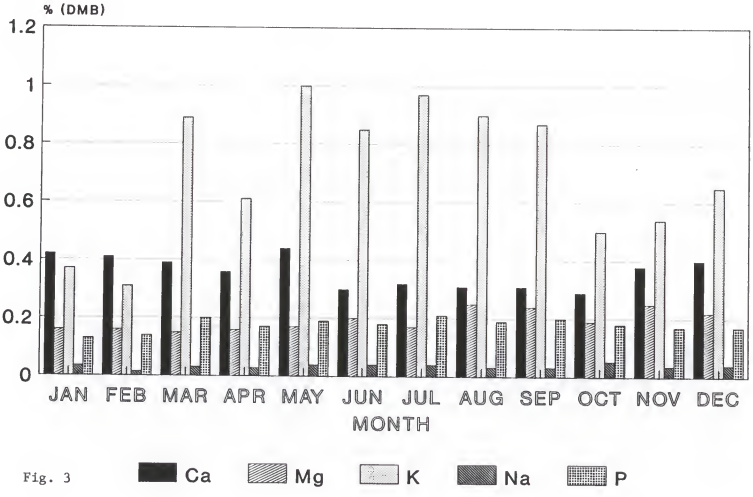


Fig. 3

# FORAGE Cu, Fe, Mn AND Zn CONCENTRATIONS MONTHLY VARIATION (1987-1988)

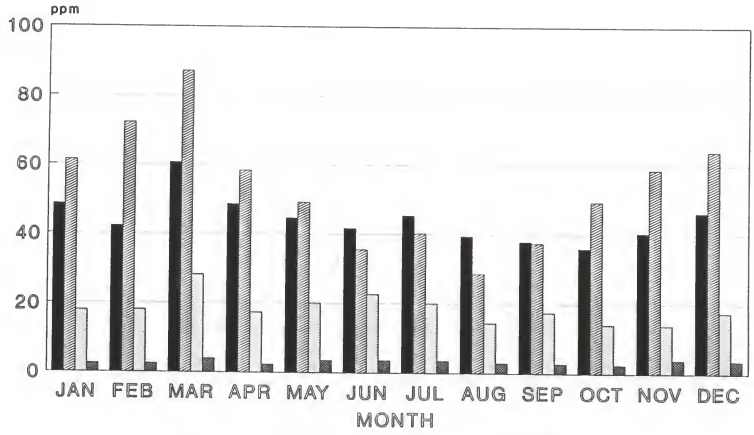


Fig. 4

# FORAGE Co, Mo AND Se CONCENTRATIONS MONTHLY VARIATION (1987-1988)

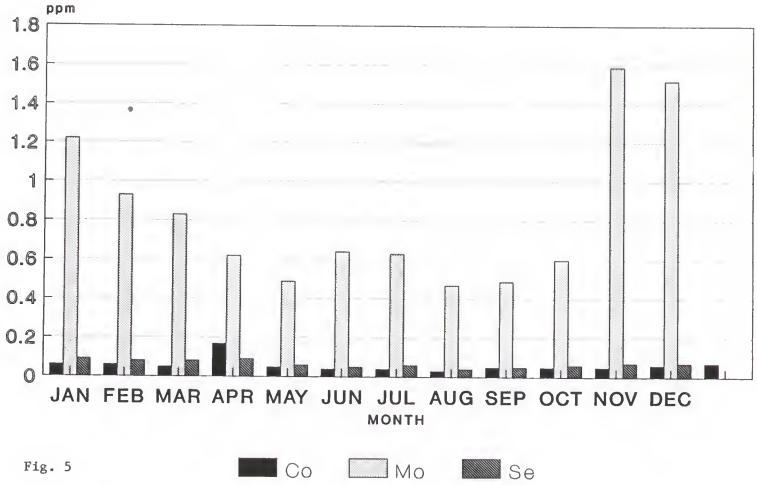


Fig. 5

# APPENDIX C

# RAW DATA

BODY WEIGHT DATA CODES

OBS = Observation number (1-308).

SAM = Sample type (1= WEIGHT).

ANL = Animal type (1= cow).

YR = Year (2-4).

MTH = Month (5= May, 11= November).

TR = Treatment (1=LP, 2=MP, 3=HP).

OB = Sample observation.

WT = Body weight, kg.

WEIGHT DATA

| OBS | SAM | ANL | YR | MTH | TR | OBS | WT |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 2 | 11 | 1 | 1 | 414.4 |
| 2 | 1 | 1 | 2 | 11 | 1 | 2 | 428.5 |
| 3 | 1 | 1 | 2 | 11 | 1 | 3 | 421.4 |
| 4 | 1 | 1 | 2 | 11 | 1 | 4 | 449.3 |
| 5 | 1 | 1 | 2 | 11 | 1 | 5 | 429.9 |
| 6 | 1 | 1 | 2 | 11 | 1 | 6 | 398.1 |
| 7 | 1 | 1 | 2 | 11 | 1 | 7 | 404.9 |
| 8 | 1 | 1 | 2 | 11 | 1 | 8 | 429.0 |
| 9 | 1 | 1 | 2 | 11 | 1 | 9 | 399.7 |
| 10 | 1 | 1 | 2 | 11 | 1 | 10 | 417.3 |
| 11 | 1 | 1 | 2 | 11 | 1 | 11 | 426.5 |
| 12 | 1 | 1 | 2 | 11 | 1 | 12 | 431.6 |
| 13 | 1 | 1 | 2 | 11 | 1 | 13 | 408.2 |
| 14 | 1 | 1 | 2 | 11 | 1 | 14 | 441.5 |
| 15 | 1 | 1 | 2 | 11 | 2 | 1 | 429.9 |
| 16 | 1 | 1 | 2 | 11 | 2 | 2 | 437.0 |
| 17 | 1 | 1 | 2 | 11 | 2 | 3 | 432.9 |
| 18 | 1 | 1 | 2 | 11 | 2 | 4 | 436.2 |
| 19 | 1 | 1 | 2 | 11 | 2 | 5 | 435.9 |
| 20 | 1 | 1 | 2 | 11 | 2 | 6 | 459.5 |
| 21 | 1 | 1 | 2 | 11 | 2 | 7 | 455.7 |
| 22 | 1 | 1 | 2 | 11 | 2 | 8 | 412.7 |
| 23 | 1 | 1 | 2 | 11 | 2 | 9 | 440.3 |
| 24 | 1 | 1 | 2 | 11 | 2 | 10 | 429.5 |
| 25 | 1 | 1 | 2 | 11 | 2 | 11 | 417.0 |
| 26 | 1 | 1 | 2 | 11 | 2 | 12 | 456.4 |
| 27 | 1 | 1 | 2 | 11 | 2 | 13 | 437.3 |
| 28 | 1 | 1 | 2 | 11 | 2 | 14 | 423.4 |
| 29 | 1 | 1 | 2 | 11 | 2 | 15 | 423.3 |
| 30 | 1 | 1 | 2 | 11 | 2 | 16 | 421.7 |
| 31 | 1 | 1 | 2 | 11 | 2 | 17 | 409.1 |
| 32 | 1 | 1 | 2 | 11 | 2 | 18 | 416.2 |
| 33 | 1 | 1 | 2 | 11 | 3 | 1 | 392.2 |
| 34 | 1 | 1 | 2 | 11 | 3 | 2 | 415.6 |
| 35 | 1 | 1 | 2 | 11 | 3 | 3 | 425.8 |
| 36 | 1 | 1 | 2 | 11 | 3 | 4 | 471.5 |
| 37 | 1 | 1 | 2 | 11 | 3 | 5 | 427.0 |
| 38 | 1 | 1 | 2 | 11 | 3 | 6 | 457.6 |
| 39 | 1 | 1 | 2 | 11 | 3 | 7 | 441.1 |
| 40 | 1 | 1 | 2 | 11 | 3 | 8 | 416.2 |
| 41 | 1 | 1 | 2 | 11 | 3 | 9 | 441.5 |
| 42 | 1 | 1 | 2 | 11 | 3 | 10 | 419.8 |
| 43 | 1 | 1 | 2 | 11 | 3 | 11 | 399.7 |
| 44 | 1 | 1 | 2 | 11 | 3 | 12 | 463.1 |
| 45 | 1 | 1 | 2 | 11 | 3 | 13 | 438.1 |
| 46 | 1 | 1 | 2 | 11 | 3 | 14 | 419.5 |

| OBS | SAM | ANL | YR | MTH | TR | OBS | WT |
|---|---|---|---|---|---|---|---|
| 47 | 1 | 1 | 2 | 11 | 3 | 15 | 420.2 |
| 48 | 1 | 1 | 2 | 11 | 3 | 16 | 421.6 |
| 49 | 1 | 1 | 2 | 11 | 3 | 17 | 438.1 |
| 50 | 1 | 1 | 2 | 11 | 3 | 18 | 444.3 |
| 51 | 1 | 1 | 2 | 11 | 3 | 19 | 425.0 |
| 52 | 1 | 1 | 2 | 11 | 3 | 20 | 429.2 |
| 53 | 1 | 1 | 2 | 11 | 3 | 21 | 406.5 |
| 54 | 1 | 1 | 2 | 11 | 3 | 22 | 443.8 |
| 55 | 1 | 1 | 2 | 11 | 3 | 23 | 404.5 |
| 56 | 1 | 1 | 3 | 5 | 1 | 1 | 417.9 |
| 57 | 1 | 1 | 3 | 5 | 1 | 2 | 387.7 |
| 58 | 1 | 1 | 3 | 5 | 1 | 3 | 407.5 |
| 59 | 1 | 1 | 3 | 5 | 1 | 4 | 400.6 |
| 60 | 1 | 1 | 3 | 5 | 1 | 5 | 406.3 |
| 61 | 1 | 1 | 3 | 5 | 1 | 6 | 395.0 |
| 62 | 1 | 1 | 3 | 5 | 1 | 7 | 389.4 |
| 63 | 1 | 1 | 3 | 5 | 1 | 8 | 391.4 |
| 64 | 1 | 1 | 3 | 5 | 1 | 9 | 378.5 |
| 65 | 1 | 1 | 3 | 5 | 1 | 10 | 381.1 |
| 66 | 1 | 1 | 3 | 5 | 1 | 11 | 453.8 |
| 67 | 1 | 1 | 3 | 5 | 1 | 12 | 401.7 |
| 68 | 1 | 1 | 3 | 5 | 1 | 13 | 411.4 |
| 69 | 1 | 1 | 3 | 5 | 1 | 14 | 375.5 |
| 70 | 1 | 1 | 3 | 5 | 1 | 15 | 384.5 |
| 71 | 1 | 1 | 3 | 5 | 1 | 16 | 390.0 |
| 72 | 1 | 1 | 3 | 5 | 1 | 17 | 399.2 |
| 73 | 1 | 1 | 3 | 5 | 1 | 18 | 390.9 |
| 74 | 1 | 1 | 3 | 5 | 1 | 19 | 403.0 |
| 75 | 1 | 1 | 3 | 5 | 1 | 20 | 372.6 |
| 76 | 1 | 1 | 3 | 5 | 1 | 21 | 380.1 |
| 77 | 1 | 1 | 3 | 5 | 1 | 22 | 385.6 |
| 78 | 1 | 1 | 3 | 5 | 2 | 1 | 375.0 |
| 79 | 1 | 1 | 3 | 5 | 2 | 2 | 399.0 |
| 80 | 1 | 1 | 3 | 5 | 2 | 3 | 398.2 |
| 81 | 1 | 1 | 3 | 5 | 2 | 4 | 416.3 |
| 82 | 1 | 1 | 3 | 5 | 2 | 5 | 412.5 |
| 83 | 1 | 1 | 3 | 5 | 2 | 6 | 391.5 |
| 84 | 1 | 1 | 3 | 5 | 2 | 7 | 411.9 |
| 85 | 1 | 1 | 3 | 5 | 2 | 8 | 401.7 |
| 86 | 1 | 1 | 3 | 5 | 2 | 9 | 425.0 |
| 87 | 1 | 1 | 3 | 5 | 2 | 10 | 406.1 |
| 88 | 1 | 1 | 3 | 5 | 2 | 11 | 409.8 |
| 89 | 1 | 1 | 3 | 5 | 2 | 12 | 356.8 |
| 90 | 1 | 1 | 3 | 5 | 2 | 13 | 397.2 |
| 91 | 1 | 1 | 3 | 5 | 2 | 14 | 377.5 |
| 92 | 1 | 1 | 3 | 5 | 2 | 15 | 400.0 |

| OBS | SAM | ANL | YR | MTH | TR | OBS | WT |
|---|---|---|---|---|---|---|---|
| 93 | 1 | 1 | 3 | 5 | 2 | 16 | 411.4 |
| 94 | 1 | 1 | 3 | 5 | 2 | 17 | 396.4 |
| 95 | 1 | 1 | 3 | 5 | 2 | 18 | 391.2 |
| 96 | 1 | 1 | 3 | 5 | 3 | 1 | 419.8 |
| 97 | 1 | 1 | 3 | 5 | 3 | 2 | 418.9 |
| 98 | 1 | 1 | 3 | 5 | 3 | 3 | 417.2 |
| 99 | 1 | 1 | 3 | 5 | 3 | 4 | 400.0 |
| 100 | 1 | 1 | 3 | 5 | 3 | 5 | 376.7 |
| 101 | 1 | 1 | 3 | 5 | 3 | 6 | 398.5 |
| 102 | 1 | 1 | 3 | 5 | 3 | 7 | 418.9 |
| 103 | 1 | 1 | 3 | 5 | 3 | 8 | 417.1 |
| 104 | 1 | 1 | 3 | 5 | 3 | 9 | 400.0 |
| 105 | 1 | 1 | 3 | 5 | 3 | 10 | 398.5 |
| 106 | 1 | 1 | 3 | 11 | 1 | 1 | 451.8 |
| 107 | 1 | 1 | 3 | 11 | 1 | 2 | 425.2 |
| 108 | 1 | 1 | 3 | 11 | 1 | 3 | 420.9 |
| 109 | 1 | 1 | 3 | 11 | 1 | 4 | 441.5 |
| 110 | 1 | 1 | 3 | 11 | 1 | 5 | 427.1 |
| 111 | 1 | 1 | 3 | 11 | 1 | 6 | 435.5 |
| 112 | 1 | 1 | 3 | 11 | 1 | 7 | 447.0 |
| 113 | 1 | 1 | 3 | 11 | 1 | 8 | 424.5 |
| 114 | 1 | 1 | 3 | 11 | 1 | 9 | 457.5 |
| 115 | 1 | 1 | 3 | 11 | 1 | 10 | 352.4 |
| 116 | 1 | 1 | 3 | 11 | 1 | 11 | 436.2 |
| 117 | 1 | 1 | 3 | 11 | 1 | 12 | 507.9 |
| 118 | 1 | 1 | 3 | 11 | 1 | 13 | 431.3 |
| 119 | 1 | 1 | 3 | 11 | 1 | 14 | 437.8 |
| 120 | 1 | 1 | 3 | 11 | 1 | 15 | 434.4 |
| 121 | 1 | 1 | 3 | 11 | 1 | 16 | 62.9 |
| 122 | 1 | 1 | 3 | 11 | 1 | 17 | 409.1 |
| 123 | 1 | 1 | 3 | 11 | 2 | 1 | 466.6 |
| 124 | 1 | 1 | 3 | 11 | 2 | 2 | 406.8 |
| 125 | 1 | 1 | 3 | 11 | 2 | 3 | 423.2 |
| 126 | 1 | 1 | 3 | 11 | 2 | 4 | 428.6 |
| 127 | 1 | 1 | 3 | 11 | 2 | 5 | 418.4 |
| 128 | 1 | 1 | 3 | 11 | 2 | 6 | 420.2 |
| 129 | 1 | 1 | 3 | 11 | 2 | 7 | 400.0 |
| 130 | 1 | 1 | 3 | 11 | 2 | 8 | 398.6 |
| 131 | 1 | 1 | 3 | 11 | 2 | 9 | 420.5 |
| 132 | 1 | 1 | 3 | 11 | 2 | 10 | 438.4 |
| 133 | 1 | 1 | 3 | 11 | 2 | 11 | 405.2 |
| 134 | 1 | 1 | 3 | 11 | 2 | 12 | 417.4 |
| 135 | 1 | 1 | 3 | 11 | 2 | 13 | 451.6 |
| 136 | 1 | 1 | 3 | 11 | 2 | 14 | 439.4 |
| 137 | 1 | 1 | 3 | 11 | 2 | 15 | 412.0 |
| 138 | 1 | 1 | 3 | 11 | 2 | 16 | 416.2 |

| OBS | SAM | ANL | YR | MTH | TR | OBS | WT |
|---|---|---|---|---|---|---|---|
| 139 | 1 | 1 | 3 | 11 | 2 | 17 | 404.5 |
| 140 | 1 | 1 | 3 | 11 | 2 | 18 | 437.5 |
| 141 | 1 | 1 | 3 | 11 | 3 | 1 | 452.7 |
| 142 | 1 | 1 | 3 | 11 | 3 | 2 | 432.6 |
| 143 | 1 | 1 | 3 | 11 | 3 | 3 | 404.7 |
| 144 | 1 | 1 | 3 | 11 | 3 | 4 | 440.6 |
| 145 | 1 | 1 | 3 | 11 | 3 | 5 | 432.3 |
| 146 | 1 | 1 | 3 | 11 | 3 | 6 | 437.0 |
| 147 | 1 | 1 | 3 | 11 | 3 | 7 | 449.5 |
| 148 | 1 | 1 | 3 | 11 | 3 | 8 | 444.1 |
| 149 | 1 | 1 | 3 | 11 | 3 | 9 | 410.6 |
| 150 | 1 | 1 | 3 | 11 | 3 | 10 | 425.9 |
| 151 | 1 | 1 | 3 | 11 | 3 | 11 | 446.3 |
| 152 | 1 | 1 | 3 | 11 | 3 | 12 | 442.7 |
| 153 | 1 | 1 | 3 | 11 | 3 | 13 | 432.3 |
| 154 | 1 | 1 | 3 | 11 | 3 | 14 | 450.2 |
| 155 | 1 | 1 | 3 | 11 | 3 | 15 | 408.8 |
| 156 | 1 | 1 | 3 | 11 | 3 | 16 | 417.9 |
| 157 | 1 | 1 | 3 | 11 | 3 | 17 | 415.7 |
| 158 | 1 | 1 | 3 | 11 | 3 | 18 | 422.5 |
| 159 | 1 | 1 | 3 | 11 | 3 | 19 | 462.0 |
| 160 | 1 | 1 | 3 | 11 | 3 | 20 | 471.6 |
| 161 | 1 | 1 | 3 | 11 | 3 | 21 | 435.5 |
| 162 | 1 | 1 | 4 | 5 | 1 | 1 | 411.9 |
| 163 | 1 | 1 | 4 | 5 | 1 | 2 | 392.6 |
| 164 | 1 | 1 | 4 | 5 | 1 | 3 | 365.5 |
| 165 | 1 | 1 | 4 | 5 | 1 | 4 | 413.0 |
| 166 | 1 | 1 | 4 | 5 | 1 | 5 | 393.5 |
| 167 | 1 | 1 | 4 | 5 | 1 | 6 | 389.9 |
| 168 | 1 | 1 | 4 | 5 | 1 | 7 | 394.1 |
| 169 | 1 | 1 | 4 | 5 | 1 | 8 | 402.5 |
| 170 | 1 | 1 | 4 | 5 | 1 | 9 | 377.3 |
| 171 | 1 | 1 | 4 | 5 | 1 | 10 | 399.4 |
| 172 | 1 | 1 | 4 | 5 | 1 | 11 | 388.0 |
| 173 | 1 | 1 | 4 | 5 | 1 | 12 | 385.4 |
| 174 | 1 | 1 | 4 | 5 | 1 | 13 | 404.1 |
| 175 | 1 | 1 | 4 | 5 | 1 | 14 | 389.5 |
| 176 | 1 | 1 | 4 | 5 | 1 | 15 | 384.8 |
| 177 | 1 | 1 | 4 | 5 | 1 | 16 | 416.7 |
| 178 | 1 | 1 | 4 | 5 | 1 | 17 | 384.5 |
| 179 | 1 | 1 | 4 | 5 | 1 | 18 | 400.0 |
| 180 | 1 | 1 | 4 | 5 | 1 | 19 | 385.7 |
| 181 | 1 | 1 | 4 | 5 | 1 | 20 | 382.5 |
| 182 | 1 | 1 | 4 | 5 | 1 | 21 | 372.7 |
| 183 | 1 | 1 | 4 | 5 | 2 | 1 | 416.7 |
| 184 | 1 | 1 | 4 | 5 | 2 | 2 | 370.1 |

| OBS | SAM | ANL | YR | MTH | TR | OBS | WT |
|---|---|---|---|---|---|---|---|
| 185 | 1 | 1 | 4 | 5 | 2 | 3 | 395.5 |
| 186 | 1 | 1 | 4 | 5 | 2 | 4 | 393.2 |
| 187 | 1 | 1 | 4 | 5 | 2 | 5 | 384.4 |
| 188 | 1 | 1 | 4 | 5 | 2 | 6 | 378.8 |
| 189 | 1 | 1 | 4 | 5 | 2 | 7 | 381.6 |
| 190 | 1 | 1 | 4 | 5 | 2 | 8 | 408.6 |
| 191 | 1 | 1 | 4 | 5 | 2 | 9 | 404.0 |
| 192 | 1 | 1 | 4 | 5 | 2 | 10 | 375.0 |
| 193 | 1 | 1 | 4 | 5 | 2 | 11 | 379.8 |
| 194 | 1 | 1 | 4 | 5 | 2 | 12 | 332.7 |
| 195 | 1 | 1 | 4 | 5 | 2 | 13 | 370.5 |
| 196 | 1 | 1 | 4 | 5 | 2 | 14 | 381.8 |
| 197 | 1 | 1 | 4 | 5 | 2 | 15 | 367.7 |
| 198 | 1 | 1 | 4 | 5 | 2 | 16 | 386.4 |
| 199 | 1 | 1 | 4 | 5 | 2 | 17 | 386.4 |
| 200 | 1 | 1 | 4 | 5 | 2 | 18 | 371.2 |
| 201 | 1 | 1 | 4 | 5 | 2 | 19 | 359.1 |
| 202 | 1 | 1 | 4 | 5 | 2 | 20 | 364.2 |
| 203 | 1 | 1 | 4 | 5 | 3 | 1 | 556.4 |
| 204 | 1 | 1 | 4 | 5 | 3 | 2 | 208.0 |
| 205 | 1 | 1 | 4 | 5 | 3 | 3 | 355.5 |
| 206 | 1 | 1 | 4 | 5 | 3 | 4 | 367.9 |
| 207 | 1 | 1 | 4 | 5 | 3 | 5 | 390.9 |
| 208 | 1 | 1 | 4 | 5 | 3 | 6 | 386.4 |
| 209 | 1 | 1 | 4 | 5 | 3 | 7 | 374.0 |
| 210 | 1 | 1 | 4 | 5 | 3 | 8 | 389.4 |
| 211 | 1 | 1 | 4 | 5 | 3 | 9 | 376.1 |
| 212 | 1 | 1 | 4 | 5 | 3 | 10 | 390.9 |
| 213 | 1 | 1 | 4 | 5 | 3 | 11 | 367.3 |
| 214 | 1 | 1 | 4 | 5 | 3 | 12 | 353.4 |
| 215 | 1 | 1 | 4 | 5 | 3 | 13 | 393.2 |
| 216 | 1 | 1 | 4 | 5 | 3 | 14 | 402.6 |
| 217 | 1 | 1 | 4 | 5 | 3 | 15 | 393.4 |
| 218 | 1 | 1 | 4 | 5 | 3 | 16 | 377.3 |
| 219 | 1 | 1 | 4 | 5 | 3 | 17 | 405.5 |
| 220 | 1 | 1 | 4 | 5 | 3 | 18 | 364.1 |
| 221 | 1 | 1 | 4 | 5 | 3 | 19 | 376.9 |
| 222 | 1 | 1 | 4 | 5 | 3 | 20 | 406.8 |
| 223 | 1 | 1 | 4 | 5 | 3 | 21 | 371.8 |
| 224 | 1 | 1 | 4 | 5 | 3 | 22 | 393.2 |
| 225 | 1 | 1 | 4 | 5 | 3 | 23 | 360.4 |
| 226 | 1 | 1 | 4 | 5 | 3 | 24 | 356.3 |
| 227 | 1 | 1 | 4 | 5 | 3 | 25 | 387.4 |
| 228 | 1 | 1 | 4 | 5 | 3 | 26 | 383.3 |
| 229 | 1 | 1 | 4 | 5 | 3 | 27 | 344.7 |
| 230 | 1 | 1 | 4 | 5 | 3 | 28 | 486.4 |

| OBS | SAM | ANL | YR | MTH | TR | OBS | WT |
|---|---|---|---|---|---|---|---|
| 231 | 1 | 1 | 4 | 5 | 3 | 29 | 367.3 |
| 232 | 1 | 1 | 4 | 5 | 3 | 30 | 358.4 |
| 233 | 1 | 1 | 4 | 5 | 3 | 31 | 379.9 |
| 234 | 1 | 1 | 4 | 5 | 3 | 32 | 376.5 |
| 235 | 1 | 1 | 4 | 5 | 3 | 33 | 351.1 |
| 236 | 1 | 1 | 4 | 11 | 1 | 1 | 377.7 |
| 237 | 1 | 1 | 4 | 11 | 1 | 2 | 426.1 |
| 238 | 1 | 1 | 4 | 11 | 1 | 3 | 428.1 |
| 239 | 1 | 1 | 4 | 11 | 1 | 4 | 446.3 |
| 240 | 1 | 1 | 4 | 11 | 1 | 5 | 441.7 |
| 241 | 1 | 1 | 4 | 11 | 1 | 6 | 434.7 |
| 242 | 1 | 1 | 4 | 11 | 1 | 7 | 436.4 |
| 243 | 1 | 1 | 4 | 11 | 1 | 8 | 416.2 |
| 244 | 1 | 1 | 4 | 11 | 1 | 9 | 441.8 |
| 245 | 1 | 1 | 4 | 11 | 1 | 10 | 441.4 |
| 246 | 1 | 1 | 4 | 11 | 1 | 11 | 442.3 |
| 247 | 1 | 1 | 4 | 11 | 1 | 12 | 436.4 |
| 248 | 1 | 1 | 4 | 11 | 1 | 13 | 426.1 |
| 249 | 1 | 1 | 4 | 11 | 1 | 14 | 428.0 |
| 250 | 1 | 1 | 4 | 11 | 1 | 15 | 451.0 |
| 251 | 1 | 1 | 4 | 11 | 1 | 16 | 426.8 |
| 252 | 1 | 1 | 4 | 11 | 1 | 17 | 409.1 |
| 253 | 1 | 1 | 4 | 11 | 1 | 18 | 430.0 |
| 254 | 1 | 1 | 4 | 11 | 1 | 19 | 433.0 |
| 255 | 1 | 1 | 4 | 11 | 1 | 20 | 409.1 |
| 256 | 1 | 1 | 4 | 11 | 1 | 21 | 464.9 |
| 257 | 1 | 1 | 4 | 11 | 2 | 1 | 428.1 |
| 258 | 1 | 1 | 4 | 11 | 2 | 2 | 429.9 |
| 259 | 1 | 1 | 4 | 11 | 2 | 3 | 436.4 |
| 260 | 1 | 1 | 4 | 11 | 2 | 4 | 462.1 |
| 261 | 1 | 1 | 4 | 11 | 2 | 5 | 439.3 |
| 262 | 1 | 1 | 4 | 11 | 2 | 6 | 431.1 |
| 263 | 1 | 1 | 4 | 11 | 2 | 7 | 456.1 |
| 264 | 1 | 1 | 4 | 11 | 2 | 8 | 475.8 |
| 265 | 1 | 1 | 4 | 11 | 2 | 9 | 462.1 |
| 266 | 1 | 1 | 4 | 11 | 2 | 10 | 426.6 |
| 267 | 1 | 1 | 4 | 11 | 2 | 11 | 432.8 |
| 268 | 1 | 1 | 4 | 11 | 2 | 12 | 422.0 |
| 269 | 1 | 1 | 4 | 11 | 2 | 13 | 429.5 |
| 270 | 1 | 1 | 4 | 11 | 2 | 14 | 434.5 |
| 271 | 1 | 1 | 4 | 11 | 2 | 15 | 433.2 |
| 272 | 1 | 1 | 4 | 11 | 2 | 16 | 444.9 |
| 273 | 1 | 1 | 4 | 11 | 2 | 17 | 417.4 |
| 274 | 1 | 1 | 4 | 11 | 2 | 18 | 458.3 |
| 275 | 1 | 1 | 4 | 11 | 2 | 19 | 409.1 |
| 276 | 1 | 1 | 4 | 11 | 3 | 1 | 453.4 |

| OBS | SAM | ANL | YR | MTH | TR | OBS | WT |
|---|---|---|---|---|---|---|---|
| 277 | 1 | 1 | 4 | 11 | 3 | 2 | 449.4 |
| 278 | 1 | 1 | 4 | 11 | 3 | 3 | 479.5 |
| 279 | 1 | 1 | 4 | 11 | 3 | 4 | 441.6 |
| 280 | 1 | 1 | 4 | 11 | 3 | 5 | 600.0 |
| 281 | 1 | 1 | 4 | 11 | 3 | 6 | 400.0 |
| 282 | 1 | 1 | 4 | 11 | 3 | 7 | 447.7 |
| 283 | 1 | 1 | 4 | 11 | 3 | 8 | 468.9 |
| 284 | 1 | 1 | 4 | 11 | 3 | 9 | 477.3 |
| 285 | 1 | 1 | 4 | 11 | 3 | 10 | 451.7 |
| 286 | 1 | 1 | 4 | 11 | 3 | 11 | 495.8 |
| 287 | 1 | 1 | 4 | 11 | 3 | 12 | 475.0 |
| 288 | 1 | 1 | 4 | 11 | 3 | 13 | 453.8 |
| 289 | 1 | 1 | 4 | 11 | 3 | 14 | 440.0 |
| 290 | 1 | 1 | 4 | 11 | 3 | 15 | 433.3 |
| 291 | 1 | 1 | 4 | 11 | 3 | 16 | 450.0 |
| 292 | 1 | 1 | 4 | 11 | 3 | 17 | 454.5 |
| 293 | 1 | 1 | 4 | 11 | 3 | 18 | 495.9 |
| 294 | 1 | 1 | 4 | 11 | 3 | 19 | 479.2 |
| 295 | 1 | 1 | 4 | 11 | 3 | 20 | 436.4 |
| 296 | 1 | 1 | 4 | 11 | 3 | 21 | 441.7 |
| 297 | 1 | 1 | 4 | 11 | 3 | 22 | 500.8 |
| 298 | 1 | 1 | 4 | 11 | 3 | 23 | 432.6 |
| 299 | 1 | 1 | 4 | 11 | 3 | 24 | 427.3 |
| 300 | 1 | 1 | 4 | 11 | 3 | 25 | 422.0 |
| 301 | 1 | 1 | 4 | 11 | 3 | 26 | 435.7 |
| 302 | 1 | 1 | 4 | 11 | 3 | 27 | 460.0 |
| 303 | 1 | 1 | 4 | 11 | 3 | 28 | 428.6 |
| 304 | 1 | 1 | 4 | 11 | 3 | 29 | 436.4 |
| 305 | 1 | 1 | 4 | 11 | 3 | 30 | 460.2 |
| 306 | 1 | 1 | 4 | 11 | 3 | 31 | 466.3 |
| 307 | 1 | 1 | 4 | 11 | 3 | 32 | 417.7 |
| 308 | 1 | 1 | 4 | 11 | 3 | 33 | 451.1 |

BLOOD SERUM DATA CODES

OBS = Observation number (1-1155).

SAM = Sample type (1=serum).

ANL = Animal type (1=cow, 2=calf, 3=open cow).

YR = Year (2-4).

MTH = Month (5= May, 11= November).

TR = Treatment (1=LP, 2=MP, 3=HP).

OB = Sample observation.

CA = Calcium, mg/100 ml.

MG = Magnesium, mg/100 ml.

P = Phosphorus, mg/100 ml.

CU = Copper, ppm.

SE = Selenium, ppm.

ZN = Zinc, ppm.

SERUM DATA

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 2 | 5 | 1 | 1 | 8.0 | 2.24 | 4.49 | 0.47 | 0.98 | . |
| 2 | 1 | 1 | 2 | 5 | 1 | 2 | 9.8 | 2.11 | 3.00 | 0.52 | 0.91 | . |
| 3 | 1 | 1 | 2 | 5 | 1 | 3 | 10.6 | 2.60 | 3.74 | 0.92 | 1.01 | . |
| 4 | 1 | 1 | 2 | 5 | 1 | 4 | 10.1 | 2.37 | 3.00 | 0.56 | 0.86 | . |
| 5 | 1 | 1 | 2 | 5 | 1 | 5 | 10.0 | 2.38 | 4.12 | 1.09 | 1.20 | . |
| 6 | 1 | 1 | 2 | 5 | 1 | 6 | 9.9 | 2.72 | 3.99 | 0.68 | 0.85 | . |
| 7 | 1 | 1 | 2 | 5 | 1 | 7 | 9.8 | 2.38 | 2.75 | 0.62 | 0.85 | . |
| 8 | 1 | 1 | 2 | 5 | 1 | 8 | 8.1 | 2.06 | 3.99 | 0.73 | 0.76 | . |
| 9 | 1 | 1 | 2 | 5 | 1 | 9 | 9.3 | 2.58 | 4.12 | 0.72 | 0.79 | . |
| 10 | 1 | 1 | 2 | 5 | 1 | 10 | 10.3 | 2.58 | 3.99 | 0.80 | 0.98 | . |
| 11 | 1 | 1 | 2 | 5 | 1 | 11 | 10.3 | 2.39 | 3.37 | 0.78 | 1.13 | . |
| 12 | 1 | 1 | 2 | 5 | 1 | 12 | 9.5 | 2.23 | 5.24 | 1.09 | 1.03 | . |
| 13 | 1 | 1 | 2 | 5 | 1 | 13 | 10.0 | 2.10 | 2.75 | 1.46 | 0.76 | . |
| 14 | 1 | 1 | 2 | 5 | 1 | 14 | 11.0 | 2.31 | 3.37 | 1.59 | 1.02 | . |
| 15 | 1 | 1 | 2 | 5 | 1 | 15 | 9.0 | 2.09 | 3.62 | 0.84 | 1.08 | . |
| 16 | 1 | 1 | 2 | 5 | 1 | 16 | 10.4 | 2.48 | 3.99 | 0.76 | 0.91 | . |
| 17 | 1 | 1 | 2 | 5 | 1 | 17 | 10.6 | 2.51 | 4.12 | 1.26 | 0.82 | . |
| 18 | 1 | 1 | 2 | 5 | 1 | 18 | 9.7 | 2.32 | 2.75 | 0.53 | 1.09 | . |
| 19 | 1 | 1 | 2 | 5 | 1 | 19 | 10.5 | 2.31 | 3.62 | 0.73 | 0.97 | . |
| 20 | 1 | 1 | 2 | 5 | 1 | 20 | 10.1 | 2.27 | 4.37 | 1.11 | 1.05 | . |
| 21 | 1 | 1 | 2 | 5 | 1 | 21 | 9.2 | 2.47 | 4.49 | 0.64 | 1.17 | . |
| 22 | 1 | 1 | 2 | 5 | 1 | 22 | 10.5 | 2.13 | 4.12 | 1.80 | 0.91 | . |
| 23 | 1 | 1 | 2 | 5 | 1 | 23 | 9.9 | 2.46 | 4.62 | 1.60 | 0.87 | . |
| 24 | 1 | 1 | 2 | 5 | 1 | 24 | 10.2 | 1.97 | 4.24 | 1.57 | 0.64 | . |
| 25 | 1 | 1 | 2 | 5 | 1 | 25 | 11.1 | 2.46 | 2.75 | 0.79 | 0.83 | . |
| 26 | 1 | 1 | 2 | 5 | 1 | 26 | 10.6 | 2.70 | 3.62 | 0.87 | 0.75 | . |
| 27 | 1 | 1 | 2 | 5 | 1 | 27 | 9.5 | 2.24 | 2.75 | 0.62 | 0.83 | . |
| 28 | 1 | 1 | 2 | 5 | 1 | 28 | 9.8 | 2.13 | 3.37 | 0.77 | 0.64 | . |
| 29 | 1 | 1 | 2 | 5 | 1 | 29 | 9.6 | 2.39 | 3.74 | 1.20 | 0.70 | . |
| 30 | 1 | 1 | 2 | 5 | 1 | 30 | 9.8 | 2.32 | 3.37 | 0.71 | 1.01 | . |
| 31 | 1 | 1 | 2 | 5 | 1 | 31 | 10.1 | 2.50 | 4.49 | 0.79 | 0.91 | . |
| 32 | 1 | 1 | 2 | 5 | 1 | 32 | 10.8 | 2.46 | 3.62 | 1.20 | 1.15 | . |
| 33 | 1 | 1 | 2 | 5 | 1 | 33 | 9.8 | 2.27 | 3.12 | 0.99 | 0.79 | . |
| 34 | 1 | 1 | 2 | 5 | 1 | 34 | 10.7 | 2.21 | 2.75 | 2.04 | 0.96 | . |
| 35 | 1 | 1 | 2 | 5 | 1 | 35 | 10.1 | 2.12 | 3.49 | 0.85 | 0.81 | . |
| 36 | 1 | 1 | 2 | 5 | 1 | 36 | 9.9 | 2.15 | 3.49 | 2.13 | 0.94 | . |
| 37 | 1 | 1 | 2 | 5 | 1 | 37 | 10.0 | 2.54 | 4.12 | 1.08 | 0.91 | . |
| 38 | 1 | 1 | 2 | 5 | 1 | 38 | 10.4 | 2.05 | 4.99 | 0.77 | 0.76 | . |
| 39 | 1 | 1 | 2 | 5 | 1 | 39 | 11.0 | 2.24 | 3.74 | 0.83 | 1.07 | . |
| 40 | 1 | 1 | 2 | 5 | 1 | 40 | 9.3 | 2.13 | 3.99 | 0.68 | 0.74 | . |
| 41 | 1 | 1 | 2 | 5 | 1 | 41 | 9.7 | 2.03 | 3.12 | 0.54 | 0.62 | . |
| 42 | 1 | 1 | 2 | 5 | 1 | 42 | 9.8 | 2.21 | 3.25 | 0.68 | 0.56 | . |
| 43 | 1 | 1 | 2 | 5 | 1 | 43 | 11.1 | 2.10 | 5.62 | 1.68 | 0.86 | . |
| 44 | 1 | 1 | 2 | 5 | 1 | 44 | 10.3 | 2.38 | 4.37 | 2.51 | 1.04 | . |
| 45 | 1 | 1 | 2 | 5 | 1 | 45 | 9.4 | 2.30 | 3.25 | 3.43 | 0.93 | . |
| 46 | 1 | 1 | 2 | 5 | 1 | 46 | 10.6 | 2.59 | 3.12 | 1.10 | 0.78 | . |
| 47 | 1 | 1 | 2 | 5 | 2 | 1 | 7.5 | 1.81 | 4.87 | 0.70 | 1.08 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48 | 1 | 1 | 2 | 5 | 2 | 2 | 8.5 | 1.97 | 4.23 | 0.86 | 1.27 | . |
| 49 | 1 | 1 | 2 | 5 | 2 | 3 | 8.3 | 1.62 | 5.25 | 1.03 | 1.21 | . |
| 50 | 1 | 1 | 2 | 5 | 2 | 4 | 8.8 | 1.98 | 5.64 | 0.98 | 1.29 | . |
| 51 | 1 | 1 | 2 | 5 | 2 | 5 | 8.7 | 1.40 | 3.72 | 0.99 | 1.20 | . |
| 52 | 1 | 1 | 2 | 5 | 2 | 6 | 8.9 | 1.70 | 5.51 | 0.97 | 1.08 | . |
| 53 | 1 | 1 | 2 | 5 | 2 | 7 | 8.3 | 1.63 | 7.30 | 1.05 | 1.26 | . |
| 54 | 1 | 1 | 2 | 5 | 2 | 8 | 9.0 | 1.72 | 5.00 | 1.20 | 1.36 | . |
| 55 | 1 | 1 | 2 | 5 | 2 | 9 | 9.6 | 1.58 | 4.74 | 0.94 | 1.27 | . |
| 56 | 1 | 1 | 2 | 5 | 2 | 10 | 9.0 | 1.87 | 4.87 | 1.38 | 1.42 | . |
| 57 | 1 | 1 | 2 | 5 | 2 | 11 | 9.5 | 1.97 | 5.64 | 1.02 | 1.45 | . |
| 58 | 1 | 1 | 2 | 5 | 2 | 12 | 8.5 | 1.71 | 5.89 | 0.88 | 1.21 | . |
| 59 | 1 | 1 | 2 | 5 | 2 | 13 | 8.3 | 1.71 | 5.89 | 1.38 | 1.33 | . |
| 60 | 1 | 1 | 2 | 5 | 2 | 14 | 8.5 | 1.65 | 5.25 | 1.04 | 1.25 | . |
| 61 | 1 | 1 | 2 | 5 | 2 | 15 | 8.0 | 1.65 | 4.61 | 0.57 | 1.36 | . |
| 62 | 1 | 1 | 2 | 5 | 2 | 16 | 9.7 | 1.28 | 5.25 | 1.07 | 1.53 | . |
| 63 | 1 | 1 | 2 | 5 | 2 | 17 | 8.5 | 1.60 | 4.87 | 1.27 | 1.34 | . |
| 64 | 1 | 1 | 2 | 5 | 2 | 18 | 8.3 | 1.69 | 4.61 | 0.88 | 1.26 | . |
| 65 | 1 | 1 | 2 | 5 | 2 | 19 | 8.2 | 1.79 | 3.20 | 0.93 | 1.45 | . |
| 66 | 1 | 1 | 2 | 5 | 2 | 20 | 8.8 | 1.84 | 3.84 | 1.28 | 1.72 | . |
| 67 | 1 | 1 | 2 | 5 | 2 | 21 | 8.2 | 1.45 | 6.53 | 0.90 | 1.58 | . |
| 68 | 1 | 1 | 2 | 5 | 2 | 22 | 8.9 | 1.59 | 4.48 | 0.96 | 1.08 | . |
| 69 | 1 | 1 | 2 | 5 | 2 | 23 | 8.8 | 1.63 | 3.97 | 0.74 | 0.83 | . |
| 70 | 1 | 1 | 2 | 5 | 2 | 24 | 9.2 | 1.85 | 5.00 | 0.63 | 0.59 | . |
| 71 | 1 | 1 | 2 | 5 | 2 | 25 | 9.2 | 1.86 | 4.74 | 0.82 | 1.06 | . |
| 72 | 1 | 1 | 2 | 5 | 2 | 26 | 9.2 | 1.92 | 6.79 | 0.72 | 1.14 | . |
| 73 | 1 | 1 | 2 | 5 | 2 | 27 | 9.9 | 1.64 | 5.12 | 0.77 | 0.95 | . |
| 74 | 1 | 1 | 2 | 5 | 2 | 28 | 8.6 | 1.68 | 4.74 | 0.74 | 1.20 | . |
| 75 | 1 | 1 | 2 | 5 | 2 | 29 | 9.2 | 1.85 | 5.12 | 0.99 | 0.92 | . |
| 76 | 1 | 1 | 2 | 5 | 2 | 30 | 8.3 | 1.44 | 4.48 | 0.55 | 0.83 | . |
| 77 | 1 | 1 | 2 | 5 | 2 | 31 | 8.7 | 1.58 | 5.64 | 0.82 | 1.06 | . |
| 78 | 1 | 1 | 2 | 5 | 2 | 32 | 9.3 | 1.81 | 4.61 | 0.73 | 1.02 | . |
| 79 | 1 | 1 | 2 | 5 | 2 | 33 | 9.0 | 1.67 | 3.72 | 0.96 | 1.07 | . |
| 80 | 1 | 1 | 2 | 5 | 2 | 34 | 8.9 | 1.63 | 4.48 | 1.11 | 1.00 | . |
| 81 | 1 | 1 | 2 | 5 | 2 | 35 | 9.4 | 1.83 | 6.41 | 1.00 | 1.22 | . |
| 82 | 1 | 1 | 2 | 5 | 2 | 36 | 8.7 | 1.61 | 4.61 | 0.93 | 0.97 | . |
| 83 | 1 | 1 | 2 | 5 | 2 | 37 | 7.8 | 1.46 | 5.00 | 0.69 | 1.46 | . |
| 84 | 1 | 1 | 2 | 5 | 2 | 38 | 8.1 | 1.53 | 6.02 | 0.69 | 1.02 | . |
| 85 | 1 | 1 | 2 | 5 | 2 | 39 | 9.5 | 1.83 | 5.00 | 1.01 | 1.04 | . |
| 86 | 1 | 1 | 2 | 5 | 2 | 40 | 7.1 | 1.58 | 5.38 | 0.67 | 0.99 | . |
| 87 | 1 | 1 | 2 | 5 | 2 | 41 | 8.9 | 1.41 | 2.69 | 0.94 | 1.08 | . |
| 88 | 1 | 1 | 2 | 5 | 2 | 42 | 9.2 | 1.60 | 4.36 | 1.01 | 1.17 | . |
| 89 | 1 | 1 | 2 | 5 | 2 | 43 | 8.5 | 1.55 | 4.74 | 0.93 | 1.08 | . |
| 90 | 1 | 1 | 2 | 5 | 2 | 44 | 9.8 | 1.84 | 4.23 | 0.96 | 1.15 | . |
| 91 | 1 | 1 | 2 | 5 | 2 | 45 | 9.3 | 1.73 | 6.28 | 0.96 | 1.23 | . |
| 92 | 1 | 1 | 2 | 5 | 2 | 46 | 8.6 | 1.63 | 3.97 | 0.75 | 1.21 | . |
| 93 | 1 | 1 | 2 | 5 | 3 | 1 | 7.0 | 2.14 | 3.85 | 0.84 | 1.55 | . |
| 94 | 1 | 1 | 2 | 5 | 3 | 2 | 9.7 | 2.01 | 5.09 | 1.02 | 1.36 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95 | 1 | 1 | 2 | 5 | 3 | 3 | 8.7 | 2.97 | 3.47 | 0.67 | 1.22 | . |
| 96 | 1 | 1 | 2 | 5 | 3 | 4 | 8.2 | 2.50 | 4.22 | 0.79 | 1.24 | . |
| 97 | 1 | 1 | 2 | 5 | 3 | 5 | 8.4 | 2.10 | 4.71 | 0.73 | 1.23 | . |
| 98 | 1 | 1 | 2 | 5 | 3 | 6 | 8.3 | 2.17 | 4.09 | 0.71 | 1.02 | . |
| 99 | 1 | 1 | 2 | 5 | 3 | 7 | 8.3 | 2.41 | 4.22 | 0.88 | 1.35 | . |
| 100 | 1 | 1 | 2 | 5 | 3 | 8 | 8.5 | 2.49 | 3.35 | 0.81 | 0.91 | . |
| 101 | 1 | 1 | 2 | 5 | 3 | 9 | 8.7 | 2.45 | 3.72 | 0.98 | 1.12 | . |
| 102 | 1 | 1 | 2 | 5 | 3 | 10 | 9.3 | 2.68 | 4.34 | 0.79 | 1.06 | . |
| 103 | 1 | 1 | 2 | 5 | 3 | 11 | 8.6 | 2.54 | 4.47 | 0.93 | 1.33 | . |
| 104 | 1 | 1 | 2 | 5 | 3 | 12 | 8.8 | 2.56 | 4.22 | 1.07 | 0.99 | . |
| 105 | 1 | 1 | 2 | 5 | 3 | 13 | 8.5 | 2.53 | 4.09 | 0.71 | 1.22 | . |
| 106 | 1 | 1 | 2 | 5 | 3 | 14 | 8.4 | 2.64 | 4.59 | 0.95 | 1.39 | . |
| 107 | 1 | 1 | 2 | 5 | 3 | 15 | 8.6 | 2.14 | 5.46 | 0.80 | 1.19 | . |
| 108 | 1 | 1 | 2 | 5 | 3 | 16 | 8.2 | 2.57 | 4.22 | 0.94 | 1.36 | . |
| 109 | 1 | 1 | 2 | 5 | 3 | 17 | 8.3 | 1.94 | 4.09 | 0.99 | 1.06 | . |
| 110 | 1 | 1 | 2 | 5 | 3 | 18 | 9.2 | 2.42 | 4.34 | 1.09 | 1.18 | . |
| 111 | 1 | 1 | 2 | 5 | 3 | 19 | 8.5 | 2.52 | 2.98 | 0.97 | 1.19 | . |
| 112 | 1 | 1 | 2 | 5 | 3 | 20 | 8.2 | 2.64 | 4.34 | 0.97 | 1.25 | . |
| 113 | 1 | 1 | 2 | 5 | 3 | 21 | 9.1 | 2.60 | 4.96 | 0.96 | 1.19 | . |
| 114 | 1 | 1 | 2 | 5 | 3 | 22 | 8.8 | 2.17 | 4.59 | 0.95 | 1.03 | . |
| 115 | 1 | 1 | 2 | 5 | 3 | 23 | 8.7 | 2.22 | 4.22 | 0.67 | 1.06 | . |
| 116 | 1 | 1 | 2 | 5 | 3 | 24 | 8.8 | 2.52 | 5.33 | 0.91 | 1.15 | . |
| 117 | 1 | 1 | 2 | 5 | 3 | 25 | 8.8 | 2.62 | 3.85 | 0.80 | 0.89 | . |
| 118 | 1 | 1 | 2 | 5 | 3 | 26 | 8.5 | 2.15 | 4.22 | 0.99 | 0.84 | . |
| 119 | 1 | 1 | 2 | 5 | 3 | 27 | 8.3 | 2.51 | 3.85 | 0.93 | 0.88 | . |
| 120 | 1 | 1 | 2 | 5 | 3 | 28 | 8.3 | 2.38 | 3.97 | 0.62 | 1.01 | . |
| 121 | 1 | 1 | 2 | 5 | 3 | 29 | 8.5 | 2.47 | 3.97 | 0.90 | 0.97 | . |
| 122 | 1 | 1 | 2 | 5 | 3 | 30 | 8.7 | 2.23 | 4.22 | 0.68 | 0.95 | . |
| 123 | 1 | 1 | 2 | 5 | 3 | 31 | 8.6 | 2.55 | 4.34 | 0.64 | 0.99 | . |
| 124 | 1 | 1 | 2 | 5 | 3 | 32 | 8.4 | 2.63 | 3.47 | 0.82 | 0.93 | . |
| 125 | 1 | 1 | 2 | 5 | 3 | 33 | 8.7 | 2.83 | 4.96 | 0.65 | 0.92 | . |
| 126 | 1 | 1 | 2 | 5 | 3 | 34 | 7.7 | 2.44 | 3.60 | 0.71 | 0.72 | . |
| 127 | 1 | 1 | 2 | 5 | 3 | 35 | 8.7 | 2.62 | 4.59 | 0.70 | 1.05 | . |
| 128 | 1 | 1 | 2 | 5 | 3 | 36 | 8.4 | 2.62 | 4.34 | 0.67 | 0.76 | . |
| 129 | 1 | 1 | 2 | 5 | 3 | 37 | 8.2 | 2.39 | 4.59 | 0.63 | 1.15 | . |
| 130 | 1 | 1 | 2 | 5 | 3 | 38 | 8.4 | 2.24 | 5.58 | 0.55 | 1.10 | . |
| 131 | 1 | 1 | 2 | 5 | 3 | 39 | 8.5 | 2.33 | 3.35 | 0.84 | 1.22 | . |
| 132 | 1 | 1 | 2 | 5 | 3 | 40 | 9.7 | 2.52 | 3.85 | 0.84 | 0.93 | . |
| 133 | 1 | 1 | 2 | 5 | 3 | 41 | 8.8 | 2.67 | 3.35 | 0.70 | 1.05 | . |
| 134 | 1 | 1 | 2 | 5 | 3 | 42 | 8.2 | 2.42 | 4.47 | 0.44 | 1.03 | . |
| 135 | 1 | 1 | 2 | 5 | 3 | 43 | 8.4 | 2.43 | 3.47 | 0.65 | 1.19 | . |
| 136 | 1 | 1 | 2 | 5 | 3 | 44 | 9.6 | 2.52 | 4.71 | 0.88 | 0.87 | . |
| 137 | 1 | 1 | 2 | 5 | 3 | 45 | 8.3 | 2.55 | 3.97 | 0.70 | 0.97 | . |
| 138 | 1 | 1 | 2 | 5 | 3 | 46 | 8.2 | 2.36 | 4.59 | 0.60 | 0.96 | . |
| 139 | 1 | 1 | 2 | 11 | 1 | 1 | 8.6 | 1.86 | 5.21 | 0.41 | 0.82 | . |
| 140 | 1 | 1 | 2 | 11 | 1 | 2 | 10.6 | 1.92 | 5.45 | 0.86 | 0.72 | . |
| 141 | 1 | 1 | 2 | 11 | 1 | 3 | 10.8 | 2.46 | 5.83 | 0.77 | 0.66 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 142 | 1 | 1 | 2 | 11 | 1 | 4 | 11.1 | 2.59 | 5.08 | 0.83 | 0.67 | . |
| 143 | 1 | 1 | 2 | 11 | 1 | 5 | 11.4 | 1.99 | 3.97 | 0.81 | 0.87 | . |
| 144 | 1 | 1 | 2 | 11 | 1 | 6 | 10.6 | 2.08 | 4.59 | 0.83 | 0.84 | . |
| 145 | 1 | 1 | 2 | 11 | 1 | 7 | 10.1 | 1.86 | 3.84 | 0.66 | 0.65 | . |
| 146 | 1 | 1 | 2 | 11 | 1 | 8 | 9.9 | 2.08 | 3.22 | 0.69 | 0.65 | . |
| 147 | 1 | 1 | 2 | 11 | 1 | 9 | 9.4 | 1.81 | 3.60 | 0.92 | 0.57 | . |
| 148 | 1 | 1 | 2 | 11 | 1 | 10 | 10.4 | 2.13 | 3.10 | 0.66 | 0.87 | . |
| 149 | 1 | 1 | 2 | 11 | 1 | 11 | 10.0 | 1.96 | 4.59 | 0.84 | 0.72 | . |
| 150 | 1 | 1 | 2 | 11 | 1 | 12 | 11.0 | 1.98 | 4.34 | 0.93 | 0.48 | . |
| 151 | 1 | 1 | 2 | 11 | 1 | 13 | 11.1 | 2.30 | 3.97 | 0.87 | 0.62 | . |
| 152 | 1 | 1 | 2 | 11 | 1 | 14 | 10.3 | 1.90 | 4.84 | 0.89 | 0.55 | . |
| 153 | 1 | 1 | 2 | 11 | 1 | 15 | 9.6 | 1.67 | 3.60 | 0.67 | 0.49 | . |
| 154 | 1 | 1 | 2 | 11 | 1 | 16 | 10.0 | 1.99 | 4.59 | 0.80 | 0.51 | . |
| 155 | 1 | 1 | 2 | 11 | 1 | 17 | 9.5 | 1.93 | 3.22 | 0.71 | 1.10 | . |
| 156 | 1 | 1 | 2 | 11 | 1 | 18 | 10.4 | 2.40 | 5.45 | 0.96 | 0.63 | . |
| 157 | 1 | 1 | 2 | 11 | 1 | 19 | 9.8 | 1.88 | 5.45 | 0.76 | 0.74 | . |
| 158 | 1 | 1 | 2 | 11 | 1 | 20 | 10.5 | 2.05 | 4.59 | 0.93 | 0.60 | . |
| 159 | 1 | 1 | 2 | 11 | 1 | 21 | 10.3 | 2.11 | 3.22 | 0.82 | 0.56 | . |
| 160 | 1 | 1 | 2 | 11 | 1 | 22 | 10.6 | 2.24 | 4.09 | 0.65 | 0.59 | . |
| 161 | 1 | 1 | 2 | 11 | 1 | 23 | 10.1 | 1.87 | 4.71 | 0.74 | 0.62 | . |
| 162 | 1 | 1 | 2 | 11 | 1 | 24 | 10.2 | 2.00 | 4.22 | 0.66 | 0.85 | . |
| 163 | 1 | 1 | 2 | 11 | 1 | 25 | 10.1 | 1.97 | 5.21 | 0.72 | 0.72 | . |
| 164 | 1 | 1 | 2 | 11 | 1 | 26 | 10.8 | 2.22 | 4.71 | 0.85 | 0.68 | . |
| 165 | 1 | 1 | 2 | 11 | 1 | 27 | 10.3 | 2.14 | 4.96 | 0.69 | 0.75 | . |
| 166 | 1 | 1 | 2 | 11 | 1 | 28 | 10.1 | 1.75 | 5.21 | 0.49 | 0.65 | . |
| 167 | 1 | 1 | 2 | 11 | 1 | 29 | 10.1 | 1.83 | 4.22 | 0.56 | 0.36 | . |
| 168 | 1 | 1 | 2 | 11 | 1 | 30 | 10.2 | 1.82 | 4.71 | 0.63 | 0.59 | . |
| 169 | 1 | 1 | 2 | 11 | 1 | 31 | 9.8 | 1.63 | 3.84 | 0.66 | 0.66 | . |
| 170 | 1 | 1 | 2 | 11 | 1 | 32 | 10.0 | 1.92 | 3.97 | 0.85 | 0.68 | . |
| 171 | 1 | 1 | 2 | 11 | 1 | 33 | 9.8 | 2.03 | 5.21 | 0.67 | 0.45 | . |
| 172 | 1 | 1 | 2 | 11 | 1 | 34 | 10.5 | 1.99 | 4.09 | 0.68 | 0.43 | . |
| 173 | 1 | 1 | 2 | 11 | 1 | 35 | 9.9 | 2.23 | 4.84 | 0.85 | 0.70 | . |
| 174 | 1 | 1 | 2 | 11 | 1 | 36 | 10.1 | 2.23 | 4.71 | 0.58 | 0.55 | . |
| 175 | 1 | 1 | 2 | 11 | 1 | 37 | 10.4 | 2.03 | 4.96 | 0.77 | 0.40 | . |
| 176 | 1 | 1 | 2 | 11 | 1 | 38 | 9.4 | 1.81 | 4.09 | 0.74 | 0.39 | . |
| 177 | 1 | 1 | 2 | 11 | 1 | 39 | 10.5 | 1.95 | 5.45 | 0.73 | 0.69 | . |
| 178 | 1 | 1 | 2 | 11 | 1 | 40 | 10.6 | 1.79 | 5.70 | 0.79 | 0.62 | . |
| 179 | 1 | 1 | 2 | 11 | 1 | 41 | 9.6 | 1.66 | 4.46 | 0.66 | 0.75 | . |
| 180 | 1 | 1 | 2 | 11 | 1 | 42 | 10.1 | 2.22 | 3.47 | 0.65 | 0.81 | . |
| 181 | 1 | 1 | 2 | 11 | 1 | 43 | 9.7 | 1.88 | 4.84 | 0.87 | 0.58 | . |
| 182 | 1 | 1 | 2 | 11 | 1 | 44 | 10.6 | 2.07 | 5.33 | 0.67 | 0.62 | . |
| 183 | 1 | 1 | 2 | 11 | 1 | 45 | 10.8 | 1.97 | 3.84 | 0.73 | 0.34 | . |
| 184 | 1 | 1 | 2 | 11 | 1 | 46 | 10.1 | 1.96 | 5.08 | 0.59 | 0.44 | . |
| 185 | 1 | 1 | 2 | 11 | 2 | 1 | 10.8 | 2.69 | 5.54 | 0.89 | 0.53 | . |
| 186 | 1 | 1 | 2 | 11 | 2 | 2 | 9.9 | 2.13 | 5.89 | 1.04 | 0.44 | . |
| 187 | 1 | 1 | 2 | 11 | 2 | 3 | 9.5 | 2.11 | 9.11 | 4.05 | 0.42 | . |
| 188 | 1 | 1 | 2 | 11 | 2 | 4 | 6.4 | 1.21 | 2.86 | 1.41 | 0.48 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 189 | 1 | 1 | 2 | 11 | 2 | 5 | 14.8 | 3.01 | 6.79 | 1.66 | 0.91 | . |
| 190 | 1 | 1 | 2 | 11 | 2 | 6 | 12.2 | 2.56 | 3.39 | 0.94 | 0.60 | . |
| 191 | 1 | 1 | 2 | 11 | 2 | 7 | 9.7 | 1.98 | 3.21 | 0.68 | 0.83 | . |
| 192 | 1 | 1 | 2 | 11 | 2 | 8 | 11.0 | 2.12 | 1.07 | 0.25 | 0.54 | . |
| 193 | 1 | 1 | 2 | 11 | 2 | 9 | 17.0 | 3.42 | 9.11 | 2.14 | 0.99 | . |
| 194 | 1 | 1 | 2 | 11 | 2 | 10 | 15.1 | 3.16 | 6.43 | 1.03 | 0.99 | . |
| 195 | 1 | 1 | 2 | 11 | 2 | 11 | 10.8 | 2.47 | 3.75 | 0.73 | 0.96 | . |
| 196 | 1 | 1 | 2 | 11 | 2 | 12 | 14.6 | 2.80 | 7.86 | 0.63 | 1.09 | . |
| 197 | 1 | 1 | 2 | 11 | 2 | 13 | 14.9 | 2.90 | 9.11 | 1.36 | 1.05 | . |
| 198 | 1 | 1 | 2 | 11 | 2 | 14 | 13.3 | 2.80 | 7.86 | 1.42 | 0.69 | . |
| 199 | 1 | 1 | 2 | 11 | 2 | 15 | 9.5 | 2.10 | 5.00 | 0.91 | 0.62 | . |
| 200 | 1 | 1 | 2 | 11 | 2 | 16 | 9.6 | 2.43 | 7.50 | 0.85 | 0.43 | . |
| 201 | 1 | 1 | 2 | 11 | 2 | 17 | 9.7 | 2.00 | 4.64 | 1.15 | 0.60 | . |
| 202 | 1 | 1 | 2 | 11 | 2 | 18 | 9.3 | 1.73 | 6.25 | 0.44 | 0.38 | . |
| 203 | 1 | 1 | 2 | 11 | 2 | 19 | 10.6 | 2.07 | 6.43 | 0.90 | 0.56 | . |
| 204 | 1 | 1 | 2 | 11 | 2 | 20 | 9.2 | 2.08 | 3.93 | 0.44 | 0.85 | . |
| 205 | 1 | 1 | 2 | 11 | 2 | 21 | 10.3 | 2.45 | 5.18 | 0.70 | 0.56 | . |
| 206 | 1 | 1 | 2 | 11 | 2 | 22 | 9.2 | 2.33 | 7.32 | 0.73 | 0.55 | . |
| 207 | 1 | 1 | 2 | 11 | 2 | 23 | 10.1 | 1.93 | 6.25 | 0.94 | 0.56 | . |
| 208 | 1 | 1 | 2 | 11 | 2 | 24 | 9.8 | 2.09 | 6.61 | 1.02 | 0.64 | . |
| 209 | 1 | 1 | 2 | 11 | 2 | 25 | 10.0 | 2.45 | 4.11 | 0.92 | 0.73 | . |
| 210 | 1 | 1 | 2 | 11 | 2 | 26 | 9.3 | 2.08 | 5.18 | 0.83 | 0.55 | . |
| 211 | 1 | 1 | 2 | 11 | 2 | 27 | 10.2 | 1.85 | 4.64 | 0.76 | 0.57 | . |
| 212 | 1 | 1 | 2 | 11 | 2 | 28 | 8.8 | 1.67 | 5.36 | 0.89 | 0.55 | . |
| 213 | 1 | 1 | 2 | 11 | 2 | 29 | 10.1 | 1.82 | 5.89 | 0.92 | 0.55 | . |
| 214 | 1 | 1 | 2 | 11 | 2 | 30 | 9.3 | 2.06 | 6.07 | 0.80 | 0.20 | . |
| 215 | 1 | 1 | 2 | 11 | 2 | 31 | 9.6 | 1.92 | 5.89 | 0.97 | 0.57 | . |
| 216 | 1 | 1 | 2 | 11 | 2 | 32 | 9.5 | 2.25 | 8.65 | 1.24 | 0.40 | . |
| 217 | 1 | 1 | 2 | 11 | 2 | 33 | 9.4 | 1.80 | 6.53 | 0.71 | 0.56 | . |
| 218 | 1 | 1 | 2 | 11 | 2 | 34 | 9.6 | 2.10 | 2.29 | 0.83 | 0.75 | . |
| 219 | 1 | 1 | 2 | 11 | 2 | 35 | 9.5 | 2.25 | 7.77 | 0.82 | 0.45 | . |
| 220 | 1 | 1 | 2 | 11 | 2 | 36 | 9.6 | 2.06 | 3.88 | 0.62 | 0.72 | . |
| 221 | 1 | 1 | 2 | 11 | 2 | 37 | 10.1 | 2.13 | 5.29 | 2.91 | 0.54 | . |
| 222 | 1 | 1 | 2 | 11 | 2 | 38 | 8.2 | 1.67 | 5.82 | 1.02 | 0.24 | . |
| 223 | 1 | 1 | 2 | 11 | 2 | 39 | 9.0 | 1.84 | 4.06 | 1.05 | 0.51 | . |
| 224 | 1 | 1 | 2 | 11 | 2 | 40 | 9.1 | 1.82 | 4.41 | 1.11 | 0.36 | . |
| 225 | 1 | 1 | 2 | 11 | 2 | 41 | 8.5 | 2.52 | 7.77 | 0.76 | 0.52 | . |
| 226 | 1 | 1 | 2 | 11 | 2 | 42 | 9.3 | 2.25 | 6.71 | 0.86 | 0.46 | . |
| 227 | 1 | 1 | 2 | 11 | 2 | 43 | 9.6 | 2.21 | 6.71 | 0.79 | 0.35 | . |
| 228 | 1 | 1 | 2 | 11 | 2 | 44 | 10.0 | 2.10 | 7.24 | 0.77 | 0.50 | . |
| 229 | 1 | 1 | 2 | 11 | 2 | 45 | 9.7 | 2.23 | 4.24 | 0.58 | 0.81 | . |
| 230 | 1 | 1 | 2 | 11 | 2 | 46 | 9.1 | 1.78 | 6.18 | 0.87 | 0.26 | . |
| 231 | 1 | 1 | 2 | 11 | 3 | 1 | 9.3 | 1.69 | 5.44 | 0.73 | 0.65 | . |
| 232 | 1 | 1 | 2 | 11 | 3 | 2 | 9.1 | 1.78 | 3.21 | 0.59 | 0.60 | . |
| 233 | 1 | 1 | 2 | 11 | 3 | 3 | 8.6 | 1.73 | 3.95 | 0.66 | 0.75 | . |
| 234 | 1 | 1 | 2 | 11 | 3 | 4 | 9.0 | 1.65 | 2.10 | 0.70 | 0.75 | . |
| 235 | 1 | 1 | 2 | 11 | 3 | 5 | 9.1 | 1.83 | 5.07 | 0.63 | 0.79 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 236 | 1 | 1 | 2 | 11 | 3 | 6 | 8.4 | 1.65 | 1.85 | 0.61 | 0.69 | . |
| 237 | 1 | 1 | 2 | 11 | 3 | 7 | 8.9 | 2.26 | 4.20 | 0.72 | 0.67 | . |
| 238 | 1 | 1 | 2 | 11 | 3 | 8 | 8.6 | 1.80 | 2.97 | 0.69 | 0.57 | . |
| 239 | 1 | 1 | 2 | 11 | 3 | 9 | 8.3 | 1.67 | 4.94 | 0.68 | 0.87 | . |
| 240 | 1 | 1 | 2 | 11 | 3 | 10 | 9.0 | 1.83 | 3.58 | 0.77 | 0.90 | . |
| 241 | 1 | 1 | 2 | 11 | 3 | 11 | 7.9 | 1.68 | 2.84 | 0.58 | 0.70 | . |
| 242 | 1 | 1 | 2 | 11 | 3 | 12 | 8.0 | 1.57 | 3.95 | 0.74 | 0.76 | . |
| 243 | 1 | 1 | 2 | 11 | 3 | 13 | 9.3 | 1.77 | 4.45 | 0.69 | 0.92 | . |
| 244 | 1 | 1 | 2 | 11 | 3 | 14 | 9.0 | 1.78 | 4.20 | 0.73 | 0.69 | . |
| 245 | 1 | 1 | 2 | 11 | 3 | 15 | 9.0 | 1.73 | 3.34 | 0.88 | 0.71 | . |
| 246 | 1 | 1 | 2 | 11 | 3 | 16 | 9.5 | 1.66 | 4.94 | 0.78 | 0.89 | . |
| 247 | 1 | 1 | 2 | 11 | 3 | 17 | 9.3 | 1.94 | 3.71 | 0.81 | 0.96 | . |
| 248 | 1 | 1 | 2 | 11 | 3 | 18 | 8.7 | 1.90 | 2.84 | 0.79 | 0.83 | . |
| 249 | 1 | 1 | 2 | 11 | 3 | 19 | 9.2 | 1.77 | 3.09 | 0.70 | 0.72 | . |
| 250 | 1 | 1 | 2 | 11 | 3 | 20 | 9.0 | 1.92 | 3.58 | 0.74 | 0.65 | . |
| 251 | 1 | 1 | 2 | 11 | 3 | 21 | 8.5 | 2.14 | 2.84 | 0.72 | 0.76 | . |
| 252 | 1 | 1 | 2 | 11 | 3 | 22 | 8.3 | 1.76 | 3.95 | 0.56 | 0.91 | . |
| 253 | 1 | 1 | 2 | 11 | 3 | 23 | 9.1 | 1.87 | 4.45 | 0.57 | 1.04 | . |
| 254 | 1 | 1 | 2 | 11 | 3 | 24 | 8.6 | 1.78 | 3.58 | 0.56 | 0.76 | . |
| 255 | 1 | 1 | 2 | 11 | 3 | 25 | 9.3 | 1.97 | 3.58 | 0.65 | 0.91 | . |
| 256 | 1 | 1 | 2 | 11 | 3 | 26 | 9.6 | 1.73 | 3.21 | 0.78 | 0.91 | . |
| 257 | 1 | 1 | 2 | 11 | 3 | 27 | 8.5 | 1.90 | 2.10 | 0.51 | 0.89 | . |
| 258 | 1 | 1 | 2 | 11 | 3 | 28 | 9.0 | 1.91 | 2.47 | 0.65 | 0.95 | . |
| 259 | 1 | 1 | 2 | 11 | 3 | 29 | 8.9 | 1.72 | 3.09 | 0.72 | 1.05 | . |
| 260 | 1 | 1 | 2 | 11 | 3 | 30 | 9.5 | 1.79 | 5.19 | 0.66 | 1.01 | . |
| 261 | 1 | 1 | 2 | 11 | 3 | 31 | 9.3 | 1.94 | 2.60 | 0.57 | 0.89 | . |
| 262 | 1 | 1 | 2 | 11 | 3 | 32 | 8.4 | 2.00 | 4.08 | 0.61 | 0.86 | . |
| 263 | 1 | 1 | 2 | 11 | 3 | 33 | 8.4 | 1.73 | 3.09 | 0.51 | 1.29 | . |
| 264 | 1 | 1 | 2 | 11 | 3 | 34 | 8.6 | 1.67 | 3.09 | 0.61 | 0.83 | . |
| 265 | 1 | 1 | 2 | 11 | 3 | 35 | 8.8 | 2.13 | 3.34 | 0.63 | 0.85 | . |
| 266 | 1 | 1 | 2 | 11 | 3 | 36 | 9.1 | 1.70 | 3.34 | 0.58 | 0.99 | . |
| 267 | 1 | 1 | 2 | 11 | 3 | 37 | 8.2 | 1.95 | 2.72 | 0.62 | 0.85 | . |
| 268 | 1 | 1 | 2 | 11 | 3 | 38 | 8.9 | 1.94 | 5.07 | 0.74 | 1.01 | . |
| 269 | 1 | 1 | 2 | 11 | 3 | 39 | 9.1 | 1.68 | 2.72 | 0.70 | 0.85 | . |
| 270 | 1 | 1 | 2 | 11 | 3 | 40 | 9.4 | 1.99 | 4.70 | 0.85 | 0.89 | . |
| 271 | 1 | 1 | 2 | 11 | 3 | 41 | 8.9 | 1.69 | 2.84 | 0.50 | 1.00 | . |
| 272 | 1 | 1 | 2 | 11 | 3 | 42 | 8.6 | 1.87 | 3.58 | 0.47 | 0.99 | . |
| 273 | 1 | 1 | 2 | 11 | 3 | 43 | 9.3 | 1.72 | 5.44 | 0.70 | 0.83 | . |
| 274 | 1 | 1 | 2 | 11 | 3 | 44 | 8.4 | 1.67 | 3.34 | 0.61 | 0.97 | . |
| 275 | 1 | 1 | 2 | 11 | 3 | 45 | 8.5 | 1.92 | 3.09 | 0.74 | 0.95 | . |
| 276 | 1 | 1 | 2 | 11 | 3 | 46 | 8.2 | 1.74 | 3.46 | 0.56 | 1.32 | . |
| 277 | 1 | 1 | 3 | 5 | 1 | 1 | 9.5 | 1.62 | 5.81 | 2.51 | 0.88 | . |
| 278 | 1 | 1 | 3 | 5 | 1 | 2 | 10.7 | 1.76 | 6.66 | 0.75 | 0.89 | . |
| 279 | 1 | 1 | 3 | 5 | 1 | 3 | 10.4 | 1.67 | 7.87 | 1.48 | 0.86 | . |
| 280 | 1 | 1 | 3 | 5 | 1 | 4 | 10.5 | 1.55 | 6.66 | 1.48 | 0.99 | . |
| 281 | 1 | 1 | 3 | 5 | 1 | 5 | 11.7 | 1.39 | 4.24 | 1.09 | 0.88 | . |
| 282 | 1 | 1 | 3 | 5 | 1 | 6 | 10.0 | 1.73 | 4.24 | 1.22 | 1.03 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 283 | 1 | 1 | 3 | 5 | 1 | 7 | 9.9 | 1.50 | 4.72 | 2.02 | 0.95 | . |
| 284 | 1 | 1 | 3 | 5 | 1 | 8 | 9.3 | 1.57 | 5.20 | 1.15 | 0.94 | . |
| 285 | 1 | 1 | 3 | 5 | 1 | 9 | 9.3 | 1.56 | 7.87 | 0.88 | 0.75 | . |
| 286 | 1 | 1 | 3 | 5 | 1 | 10 | 9.5 | 1.82 | 4.24 | 1.02 | 0.91 | . |
| 287 | 1 | 1 | 3 | 5 | 1 | 11 | 10.9 | 1.55 | 3.15 | 1.08 | 0.91 | . |
| 288 | 1 | 1 | 3 | 5 | 1 | 12 | 9.5 | 1.78 | 5.93 | 0.85 | 0.76 | . |
| 289 | 1 | 1 | 3 | 5 | 1 | 13 | 10.4 | 1.63 | 6.90 | 0.96 | 0.87 | . |
| 290 | 1 | 1 | 3 | 5 | 1 | 14 | 9.4 | 1.37 | 6.53 | 1.74 | 0.81 | . |
| 291 | 1 | 1 | 3 | 5 | 1 | 15 | 10.0 | 1.45 | 4.96 | 1.21 | 0.91 | . |
| 292 | 1 | 1 | 3 | 5 | 1 | 16 | 10.6 | 1.69 | 6.41 | 0.91 | 0.72 | . |
| 293 | 1 | 1 | 3 | 5 | 1 | 17 | 10.5 | 1.46 | 5.20 | 1.45 | 0.85 | . |
| 294 | 1 | 1 | 3 | 5 | 1 | 18 | 10.2 | 1.28 | 3.27 | 0.95 | 1.26 | . |
| 295 | 1 | 1 | 3 | 5 | 1 | 19 | 9.0 | 1.39 | 5.81 | 1.11 | 0.73 | . |
| 296 | 1 | 1 | 3 | 5 | 1 | 20 | 10.2 | 1.97 | 3.39 | 2.80 | 0.85 | . |
| 297 | 1 | 1 | 3 | 5 | 1 | 21 | 10.2 | 1.48 | 6.78 | 1.01 | 0.95 | . |
| 298 | 1 | 1 | 3 | 5 | 1 | 22 | 10.2 | 1.66 | 5.69 | 0.94 | 0.78 | . |
| 299 | 1 | 1 | 3 | 5 | 1 | 23 | 11.7 | 1.76 | 5.08 | 0.60 | 0.98 | . |
| 300 | 1 | 1 | 3 | 5 | 1 | 24 | 9.9 | 1.56 | 5.08 | 2.29 | 0.63 | . |
| 301 | 1 | 1 | 3 | 5 | 1 | 25 | 11.1 | 1.32 | 3.63 | 1.25 | 1.00 | . |
| 302 | 1 | 1 | 3 | 5 | 1 | 26 | 10.0 | 1.55 | 4.24 | 0.67 | 0.79 | . |
| 303 | 1 | 1 | 3 | 5 | 1 | 27 | 10.1 | 1.47 | 5.45 | 0.92 | 0.71 | . |
| 304 | 1 | 1 | 3 | 5 | 1 | 28 | 11.7 | 1.79 | 6.90 | 0.95 | 0.83 | . |
| 305 | 1 | 1 | 3 | 5 | 1 | 29 | 12.1 | 1.60 | 4.48 | 1.22 | 0.90 | . |
| 306 | 1 | 1 | 3 | 5 | 1 | 30 | 11.0 | 1.78 | 6.90 | 1.16 | 0.93 | . |
| 307 | 1 | 1 | 3 | 5 | 1 | 31 | 10.5 | 1.70 | 5.20 | 0.90 | 0.80 | . |
| 308 | 1 | 1 | 3 | 5 | 1 | 32 | 10.6 | 1.72 | 4.72 | 1.24 | 0.99 | . |
| 309 | 1 | 1 | 3 | 5 | 1 | 33 | 9.5 | 1.23 | 5.45 | 1.36 | 1.03 | . |
| 310 | 1 | 1 | 3 | 5 | 1 | 34 | 9.9 | 1.99 | 3.03 | 0.78 | 0.83 | . |
| 311 | 1 | 1 | 3 | 5 | 1 | 35 | 8.7 | 1.45 | 5.81 | 0.92 | 1.08 | . |
| 312 | 1 | 1 | 3 | 5 | 1 | 36 | 10.5 | 1.23 | 6.05 | 0.75 | 0.81 | . |
| 313 | 1 | 1 | 3 | 5 | 1 | 37 | 10.0 | 1.38 | 3.39 | 0.83 | 0.81 | . |
| 314 | 1 | 1 | 3 | 5 | 1 | 38 | 10.3 | 1.39 | 5.20 | 1.02 | 0.95 | . |
| 315 | 1 | 1 | 3 | 5 | 1 | 39 | 10.1 | 1.35 | 6.29 | 1.03 | 1.11 | . |
| 316 | 1 | 1 | 3 | 5 | 1 | 40 | 10.8 | 1.49 | 6.29 | 0.90 | 0.90 | . |
| 317 | 1 | 1 | 3 | 5 | 1 | 41 | 9.4 | 1.74 | 4.84 | 1.24 | 0.98 | . |
| 318 | 1 | 1 | 3 | 5 | 1 | 42 | 11.0 | 1.34 | 5.32 | 1.02 | 1.08 | . |
| 319 | 1 | 1 | 3 | 5 | 1 | 43 | 11.3 | 1.80 | 4.96 | 0.87 | 0.97 | . |
| 320 | 1 | 1 | 3 | 5 | 1 | 44 | 10.1 | 1.40 | 5.08 | 0.70 | 0.55 | . |
| 321 | 1 | 1 | 3 | 5 | 1 | 45 | 10.4 | 2.06 | 5.45 | 0.85 | 0.79 | . |
| 322 | 1 | 1 | 3 | 5 | 1 | 46 | 10.8 | 1.27 | 4.84 | 1.01 | 1.09 | . |
| 323 | 1 | 1 | 3 | 5 | 2 | 1 | 8.9 | 2.47 | 3.53 | 0.68 | 0.97 | . |
| 324 | 1 | 1 | 3 | 5 | 2 | 2 | 9.5 | 2.61 | 2.43 | 1.73 | 1.25 | . |
| 325 | 1 | 1 | 3 | 5 | 2 | 3 | 8.7 | 1.87 | 2.19 | 0.91 | 1.05 | . |
| 326 | 1 | 1 | 3 | 5 | 2 | 4 | 7.5 | 2.57 | 1.34 | 0.82 | 1.61 | . |
| 327 | 1 | 1 | 3 | 5 | 2 | 5 | 9.0 | 3.03 | 2.92 | 0.92 | 1.32 | . |
| 328 | 1 | 1 | 3 | 5 | 2 | 6 | 8.7 | 2.67 | 2.31 | 1.01 | 1.07 | . |
| 329 | 1 | 1 | 3 | 5 | 2 | 7 | 9.3 | 2.72 | 3.41 | 0.87 | 1.19 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 330 | 1 | 1 | 3 | 5 | 2 | 8 | 7.0 | 2.85 | 2.43 | 0.96 | 1.21 | . |
| 331 | 1 | 1 | 3 | 5 | 2 | 9 | 7.2 | 2.25 | 2.68 | 1.19 | 1.71 | . |
| 332 | 1 | 1 | 3 | 5 | 2 | 10 | 7.5 | 2.84 | 2.55 | 1.10 | 1.56 | . |
| 333 | 1 | 1 | 3 | 5 | 2 | 11 | 8.5 | 2.60 | 1.34 | 0.79 | 0.79 | . |
| 334 | 1 | 1 | 3 | 5 | 2 | 12 | 8.2 | 2.55 | 2.55 | 0.92 | 1.50 | . |
| 335 | 1 | 1 | 3 | 5 | 2 | 13 | 8.1 | 2.51 | 1.34 | 1.43 | 0.88 | . |
| 336 | 1 | 1 | 3 | 5 | 2 | 14 | 7.9 | 2.83 | 2.19 | 0.87 | 1.34 | . |
| 337 | 1 | 1 | 3 | 5 | 2 | 15 | 8.6 | 2.65 | 1.82 | 0.89 | 0.96 | . |
| 338 | 1 | 1 | 3 | 5 | 2 | 16 | 9.5 | 2.62 | 1.09 | 0.87 | 0.80 | . |
| 339 | 1 | 1 | 3 | 5 | 2 | 17 | 7.3 | 2.04 | 3.41 | 0.65 | 9.10 | . |
| 340 | 1 | 1 | 3 | 5 | 2 | 18 | 8.7 | 2.38 | 2.43 | 0.86 | 1.09 | . |
| 341 | 1 | 1 | 3 | 5 | 2 | 19 | 8.0 | 2.38 | 2.31 | 1.23 | 1.30 | . |
| 342 | 1 | 1 | 3 | 5 | 2 | 20 | 7.4 | 2.29 | 1.58 | 0.99 | 1.67 | . |
| 343 | 1 | 1 | 3 | 5 | 2 | 21 | 8.1 | 2.77 | 2.80 | 1.12 | 1.54 | . |
| 344 | 1 | 1 | 3 | 5 | 2 | 22 | 7.9 | 1.91 | 1.58 | 0.61 | 0.99 | . |
| 345 | 1 | 1 | 3 | 5 | 2 | 23 | 7.2 | 2.70 | 1.70 | 0.88 | 1.25 | . |
| 346 | 1 | 1 | 3 | 5 | 2 | 24 | 8.4 | 2.10 | 1.09 | 1.17 | 0.93 | . |
| 347 | 1 | 1 | 3 | 5 | 2 | 25 | 7.0 | 2.19 | 1.82 | 2.82 | 1.00 | . |
| 348 | 1 | 1 | 3 | 5 | 2 | 26 | 8.9 | 3.12 | 2.31 | 1.23 | 1.87 | . |
| 349 | 1 | 1 | 3 | 5 | 2 | 27 | 8.8 | 2.59 | 3.41 | 2.13 | 1.44 | . |
| 350 | 1 | 1 | 3 | 5 | 2 | 28 | 7.8 | 2.91 | 1.95 | 1.07 | 1.00 | . |
| 351 | 1 | 1 | 3 | 5 | 2 | 29 | 9.0 | 3.01 | 3.16 | 0.74 | 1.54 | . |
| 352 | 1 | 1 | 3 | 5 | 2 | 30 | 7.8 | 2.25 | 2.80 | 1.82 | 3.47 | . |
| 353 | 1 | 1 | 3 | 5 | 2 | 31 | 8.2 | 2.36 | 2.43 | 0.61 | 0.86 | . |
| 354 | 1 | 1 | 3 | 5 | 2 | 32 | 8.8 | 2.50 | 2.92 | 0.81 | 0.70 | . |
| 355 | 1 | 1 | 3 | 5 | 2 | 33 | 8.2 | 2.30 | 2.92 | 0.47 | 0.65 | . |
| 356 | 1 | 1 | 3 | 5 | 2 | 34 | 9.4 | 2.40 | 2.92 | 0.87 | 0.76 | . |
| 357 | 1 | 1 | 3 | 5 | 2 | 35 | 9.3 | 2.20 | 2.55 | 0.64 | 0.93 | . |
| 358 | 1 | 1 | 3 | 5 | 2 | 36 | 8.8 | 2.86 | 2.07 | 0.59 | 1.05 | . |
| 359 | 1 | 1 | 3 | 5 | 2 | 37 | 8.6 | 2.32 | 2.43 | 0.67 | 0.95 | . |
| 360 | 1 | 1 | 3 | 5 | 2 | 38 | 7.5 | 2.72 | 3.04 | 0.84 | 0.90 | . |
| 361 | 1 | 1 | 3 | 5 | 2 | 39 | 7.3 | 2.17 | 1.22 | 1.34 | 1.75 | . |
| 362 | 1 | 1 | 3 | 5 | 2 | 40 | 7.5 | 2.54 | 1.95 | 1.35 | 1.92 | . |
| 363 | 1 | 1 | 3 | 5 | 2 | 41 | 8.7 | 2.74 | 4.26 | 0.64 | 1.18 | . |
| 364 | 1 | 1 | 3 | 5 | 2 | 42 | 9.0 | 2.87 | 2.07 | 0.56 | 0.77 | . |
| 365 | 1 | 1 | 3 | 5 | 2 | 43 | 9.2 | 2.39 | 3.53 | 0.94 | 0.66 | . |
| 366 | 1 | 1 | 3 | 5 | 2 | 44 | 9.1 | 2.20 | 2.68 | 0.89 | 1.66 | . |
| 367 | 1 | 1 | 3 | 5 | 2 | 45 | 9.4 | 2.61 | 3.77 | 0.80 | 0.74 | . |
| 368 | 1 | 1 | 3 | 5 | 2 | 46 | 9.6 | 1.96 | 3.04 | 0.66 | 0.56 | . |
| 369 | 1 | 1 | 3 | 5 | 3 | 1 | 10.3 | 2.04 | 4.22 | 0.80 | 0.84 | . |
| 370 | 1 | 1 | 3 | 5 | 3 | 2 | 9.5 | 1.48 | 3.14 | 0.67 | 0.84 | . |
| 371 | 1 | 1 | 3 | 5 | 3 | 3 | 9.7 | 1.31 | 4.46 | 0.79 | 1.05 | . |
| 372 | 1 | 1 | 3 | 5 | 3 | 4 | 8.1 | 1.42 | 4.22 | 0.39 | 0.96 | . |
| 373 | 1 | 1 | 3 | 5 | 3 | 5 | 9.1 | 1.61 | 3.02 | 1.02 | 0.92 | . |
| 374 | 1 | 1 | 3 | 5 | 3 | 6 | 9.5 | 1.88 | 4.70 | 0.88 | 1.20 | . |
| 375 | 1 | 1 | 3 | 5 | 3 | 7 | 9.0 | 1.70 | 4.34 | 0.43 | 0.91 | . |
| 376 | 1 | 1 | 3 | 5 | 3 | 8 | 9.1 | 1.76 | 5.55 | 0.93 | 0.99 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 377 | 1 | 1 | 3 | 5 | 3 | 9 | 9.2 | 1.60 | 3.74 | 2.09 | 1.11 | . |
| 378 | 1 | 1 | 3 | 5 | 3 | 10 | 8.4 | 1.92 | 4.10 | 0.97 | 0.93 | . |
| 379 | 1 | 1 | 3 | 5 | 3 | 11 | 8.9 | 1.89 | 4.10 | 0.58 | 1.02 | . |
| 380 | 1 | 1 | 3 | 5 | 3 | 12 | 9.7 | 1.67 | 5.31 | 0.73 | 1.13 | . |
| 381 | 1 | 1 | 3 | 5 | 3 | 13 | 9.4 | 1.17 | 3.74 | 0.38 | 0.99 | . |
| 382 | 1 | 1 | 3 | 5 | 3 | 14 | 9.8 | 1.38 | 3.98 | 2.74 | 1.01 | . |
| 383 | 1 | 1 | 3 | 5 | 3 | 15 | 10.0 | 1.72 | 4.83 | 1.93 | 0.71 | . |
| 384 | 1 | 1 | 3 | 5 | 3 | 16 | 10.0 | 1.95 | 4.58 | 1.90 | 1.06 | . |
| 385 | 1 | 1 | 3 | 5 | 3 | 17 | 9.4 | 1.87 | 5.31 | 0.67 | 0.88 | . |
| 386 | 1 | 1 | 3 | 5 | 3 | 18 | 8.7 | 1.37 | 3.02 | 0.77 | 1.15 | . |
| 387 | 1 | 1 | 3 | 5 | 3 | 19 | 9.6 | 1.66 | 4.10 | 0.24 | 1.20 | . |
| 388 | 1 | 1 | 3 | 5 | 3 | 20 | 10.2 | 1.68 | 4.46 | 0.75 | 1.23 | . |
| 389 | 1 | 1 | 3 | 5 | 3 | 21 | 10.2 | 1.41 | 4.22 | 0.49 | 1.13 | . |
| 390 | 1 | 1 | 3 | 5 | 3 | 22 | 9.1 | 1.70 | 4.34 | 1.10 | 0.80 | . |
| 391 | 1 | 1 | 3 | 5 | 3 | 23 | 9.9 | 1.82 | 4.22 | 1.41 | 0.78 | . |
| 392 | 1 | 1 | 3 | 5 | 3 | 24 | 9.2 | 1.73 | 3.86 | 0.78 | 0.89 | . |
| 393 | 1 | 1 | 3 | 5 | 3 | 25 | 8.8 | 2.26 | 4.34 | 0.85 | 1.09 | . |
| 394 | 1 | 1 | 3 | 5 | 3 | 26 | 9.8 | 2.13 | 5.55 | 1.04 | 1.00 | . |
| 395 | 1 | 1 | 3 | 5 | 3 | 27 | 9.5 | 1.59 | 5.19 | 0.88 | 1.06 | . |
| 396 | 1 | 1 | 3 | 5 | 3 | 28 | 9.1 | 1.93 | 2.53 | 1.72 | 1.12 | . |
| 397 | 1 | 1 | 3 | 5 | 3 | 29 | 9.6 | 1.37 | 4.34 | 0.61 | 0.78 | . |
| 398 | 1 | 1 | 3 | 5 | 3 | 30 | 9.5 | 1.68 | 4.70 | 0.96 | 1.04 | . |
| 399 | 1 | 1 | 3 | 5 | 3 | 31 | 10.0 | 1.42 | 5.79 | 0.82 | 0.93 | . |
| 400 | 1 | 1 | 3 | 5 | 3 | 32 | 10.6 | 1.64 | 3.86 | 1.22 | 1.07 | . |
| 401 | 1 | 1 | 3 | 5 | 3 | 33 | 9.0 | 1.42 | 3.98 | 0.75 | 0.93 | . |
| 402 | 1 | 1 | 3 | 5 | 3 | 34 | 9.4 | 1.29 | 5.31 | 0.73 | 1.12 | . |
| 403 | 1 | 1 | 3 | 5 | 3 | 35 | 8.7 | 1.79 | 4.22 | 0.74 | 0.90 | . |
| 404 | 1 | 1 | 3 | 5 | 3 | 36 | 9.5 | 1.83 | 4.46 | 0.46 | 1.06 | . |
| 405 | 1 | 1 | 3 | 5 | 3 | 37 | 9.6 | 1.94 | 4.10 | 1.06 | 1.01 | . |
| 406 | 1 | 1 | 3 | 5 | 3 | 38 | 9.4 | 1.45 | 3.62 | 2.05 | 0.98 | . |
| 407 | 1 | 1 | 3 | 5 | 3 | 39 | 10.3 | 1.56 | 4.95 | 0.80 | 0.85 | . |
| 408 | 1 | 1 | 3 | 5 | 3 | 40 | 8.8 | 1.85 | 4.22 | 5.80 | 1.10 | . |
| 409 | 1 | 1 | 3 | 5 | 3 | 41 | 8.9 | 1.55 | 4.95 | 0.71 | 0.88 | . |
| 410 | 1 | 1 | 3 | 5 | 3 | 42 | 9.1 | 1.53 | 2.90 | 1.11 | 1.08 | . |
| 411 | 1 | 1 | 3 | 5 | 3 | 43 | 8.3 | 1.32 | 3.86 | 0.57 | 0.89 | . |
| 412 | 1 | 1 | 3 | 5 | 3 | 44 | 9.9 | 1.53 | 4.58 | 0.97 | 0.97 | . |
| 413 | 1 | 1 | 3 | 5 | 3 | 45 | 10.5 | 1.55 | 4.83 | 2.99 | 1.05 | . |
| 414 | 1 | 1 | 3 | 5 | 3 | 46 | 8.9 | 1.84 | 5.07 | 0.61 | 1.00 | . |
| 415 | 1 | 1 | 3 | 11 | 1 | 1 | 7.5 | 1.94 | 4.27 | 0.73 | 0.86 | . |
| 416 | 1 | 1 | 3 | 11 | 1 | 2 | 8.6 | 2.05 | 4.63 | 0.72 | 0.96 | . |
| 417 | 1 | 1 | 3 | 11 | 1 | 3 | 8.2 | 1.77 | 4.39 | 0.62 | 1.01 | . |
| 418 | 1 | 1 | 3 | 11 | 1 | 4 | 9.0 | 1.98 | 4.02 | 0.52 | 0.71 | . |
| 419 | 1 | 1 | 3 | 11 | 1 | 5 | 9.1 | 2.14 | 3.54 | 0.55 | 1.11 | . |
| 420 | 1 | 1 | 3 | 11 | 1 | 6 | 8.8 | 2.15 | 5.24 | 0.74 | 0.99 | . |
| 421 | 1 | 1 | 3 | 11 | 1 | 7 | 9.1 | 2.02 | 3.41 | 0.74 | 1.13 | . |
| 422 | 1 | 1 | 3 | 11 | 1 | 8 | 8.8 | 1.85 | 4.51 | 0.66 | 0.78 | . |
| 423 | 1 | 1 | 3 | 11 | 1 | 9 | 8.4 | 2.13 | 4.63 | 0.29 | 0.96 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 424 | 1 | 1 | 3 | 11 | 1 | 10 | 8.7 | 2.08 | 3.90 | 0.61 | 0.90 | . |
| 425 | 1 | 1 | 3 | 11 | 1 | 11 | 8.9 | 1.68 | 4.76 | 0.46 | 0.91 | . |
| 426 | 1 | 1 | 3 | 11 | 1 | 12 | 8.2 | 1.83 | 3.41 | 0.38 | 0.83 | . |
| 427 | 1 | 1 | 3 | 11 | 1 | 13 | 9.1 | 2.10 | 3.41 | 0.79 | 0.67 | . |
| 428 | 1 | 1 | 3 | 11 | 1 | 14 | 8.6 | 1.95 | 3.66 | 0.44 | 1.20 | . |
| 429 | 1 | 1 | 3 | 11 | 1 | 15 | 11.3 | 2.51 | 4.76 | 0.55 | 0.95 | . |
| 430 | 1 | 1 | 3 | 11 | 1 | 16 | 9.2 | 1.63 | 4.51 | 0.40 | 1.01 | . |
| 431 | 1 | 1 | 3 | 11 | 1 | 17 | 10.6 | 1.93 | 4.88 | 0.50 | 1.13 | . |
| 432 | 1 | 1 | 3 | 11 | 1 | 18 | 8.1 | 2.04 | 2.93 | 0.47 | 0.97 | . |
| 433 | 1 | 1 | 3 | 11 | 1 | 19 | 8.5 | 2.00 | 4.51 | 0.28 | 0.91 | . |
| 434 | 1 | 1 | 3 | 11 | 1 | 20 | 8.2 | 1.91 | 4.88 | 0.18 | 1.26 | . |
| 435 | 1 | 1 | 3 | 11 | 1 | 21 | 8.4 | 1.61 | 4.51 | 0.36 | 1.21 | . |
| 436 | 1 | 1 | 3 | 11 | 1 | 22 | 8.0 | 2.03 | 4.15 | 0.78 | 1.13 | . |
| 437 | 1 | 1 | 3 | 11 | 1 | 23 | 8.1 | 2.02 | 5.00 | 0.84 | 1.09 | . |
| 438 | 1 | 1 | 3 | 11 | 1 | 24 | 8.9 | 1.93 | 4.02 | 0.47 | 0.77 | . |
| 439 | 1 | 1 | 3 | 11 | 1 | 25 | 9.8 | 1.97 | 4.76 | 0.55 | 0.81 | . |
| 440 | 1 | 1 | 3 | 11 | 1 | 26 | 9.1 | 2.03 | 5.37 | 0.75 | 0.77 | . |
| 441 | 1 | 1 | 3 | 11 | 1 | 27 | 9.2 | 2.08 | 3.17 | 0.69 | 0.82 | . |
| 442 | 1 | 1 | 3 | 11 | 1 | 28 | 8.9 | 2.10 | 3.17 | 0.73 | 0.90 | . |
| 443 | 1 | 1 | 3 | 11 | 1 | 29 | 8.6 | 1.77 | 4.02 | 0.56 | 1.01 | . |
| 444 | 1 | 1 | 3 | 11 | 1 | 30 | 8.6 | 1.89 | 3.78 | 0.56 | 0.68 | . |
| 445 | 1 | 1 | 3 | 11 | 1 | 31 | 9.2 | 1.72 | 4.88 | 0.63 | 0.83 | . |
| 446 | 1 | 1 | 3 | 11 | 1 | 32 | 10.2 | 1.79 | 5.49 | 0.67 | 0.92 | . |
| 447 | 1 | 1 | 3 | 11 | 1 | 33 | 9.1 | 2.08 | 3.78 | 0.66 | 0.78 | . |
| 448 | 1 | 1 | 3 | 11 | 1 | 34 | 9.2 | 1.71 | 5.00 | 0.61 | 0.98 | . |
| 449 | 1 | 1 | 3 | 11 | 1 | 35 | 8.4 | 2.15 | 6.22 | 0.53 | 1.10 | . |
| 450 | 1 | 1 | 3 | 11 | 1 | 36 | 9.9 | 1.99 | 4.76 | 0.82 | 1.47 | . |
| 451 | 1 | 1 | 3 | 11 | 1 | 37 | 7.8 | 1.87 | 4.63 | 0.75 | 0.99 | . |
| 452 | 1 | 1 | 3 | 11 | 1 | 38 | 8.7 | 1.91 | 5.24 | 0.56 | 1.07 | . |
| 453 | 1 | 1 | 3 | 11 | 1 | 39 | 8.9 | 1.99 | 4.39 | 0.41 | 1.10 | . |
| 454 | 1 | 1 | 3 | 11 | 1 | 40 | 8.0 | 1.74 | 4.76 | 0.55 | 0.98 | . |
| 455 | 1 | 1 | 3 | 11 | 1 | 41 | 9.1 | 1.74 | 4.39 | 0.64 | 1.29 | . |
| 456 | 1 | 1 | 3 | 11 | 1 | 42 | 8.8 | 1.57 | 5.61 | 0.51 | 0.95 | . |
| 457 | 1 | 1 | 3 | 11 | 1 | 43 | 8.4 | 2.03 | 3.41 | 0.52 | 1.20 | . |
| 458 | 1 | 1 | 3 | 11 | 1 | 44 | 8.4 | 1.60 | 5.73 | 0.37 | 1.17 | . |
| 459 | 1 | 1 | 3 | 11 | 1 | 45 | 8.1 | 1.73 | 5.73 | 0.56 | 1.10 | . |
| 460 | 1 | 1 | 3 | 11 | 1 | 46 | 8.6 | 1.87 | 4.02 | 0.30 | 0.81 | . |
| 461 | 1 | 1 | 3 | 11 | 2 | 1 | 8.0 | 2.13 | 4.45 | 0.67 | 0.79 | . |
| 462 | 1 | 1 | 3 | 11 | 2 | 2 | 8.8 | 2.16 | 3.82 | 0.65 | 0.87 | . |
| 463 | 1 | 1 | 3 | 11 | 2 | 3 | 8.1 | 2.23 | 3.56 | 0.64 | 0.64 | . |
| 464 | 1 | 1 | 3 | 11 | 2 | 4 | 7.5 | 1.88 | 4.58 | 0.46 | 0.77 | . |
| 465 | 1 | 1 | 3 | 11 | 2 | 5 | 8.4 | 1.95 | 2.67 | 0.81 | 0.99 | . |
| 466 | 1 | 1 | 3 | 11 | 2 | 6 | 8.1 | 1.92 | 5.09 | 0.52 | 0.96 | . |
| 467 | 1 | 1 | 3 | 11 | 2 | 7 | 8.0 | 2.32 | 3.18 | 0.73 | 0.96 | . |
| 468 | 1 | 1 | 3 | 11 | 2 | 8 | 9.1 | 2.25 | 4.58 | 0.56 | 0.80 | . |
| 469 | 1 | 1 | 3 | 11 | 2 | 9 | 8.1 | 2.16 | 3.94 | 0.58 | 0.84 | . |
| 470 | 1 | 1 | 3 | 11 | 2 | 10 | 8.3 | 1.88 | 3.56 | 0.48 | 0.62 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 471 | 1 | 1 | 3 | 11 | 2 | 11 | 8.0 | 1.94 | 3.94 | 0.71 | 0.88 | . |
| 472 | 1 | 1 | 3 | 11 | 2 | 12 | 7.5 | 1.72 | 3.94 | 0.43 | 1.04 | . |
| 473 | 1 | 1 | 3 | 11 | 2 | 13 | 7.9 | 1.96 | 4.71 | 0.54 | 0.60 | . |
| 474 | 1 | 1 | 3 | 11 | 2 | 14 | 8.0 | 1.96 | 3.94 | 0.55 | 0.75 | . |
| 475 | 1 | 1 | 3 | 11 | 2 | 15 | 7.9 | 1.68 | 5.34 | 0.54 | 0.78 | . |
| 476 | 1 | 1 | 3 | 11 | 2 | 16 | 8.3 | 2.19 | 5.09 | 0.44 | 0.88 | . |
| 477 | 1 | 1 | 3 | 11 | 2 | 17 | 8.7 | 2.01 | 5.47 | 0.70 | 0.93 | . |
| 478 | 1 | 1 | 3 | 11 | 2 | 18 | 8.1 | 2.18 | 5.72 | 0.64 | 0.98 | . |
| 479 | 1 | 1 | 3 | 11 | 2 | 19 | 8.2 | 2.25 | 5.60 | 0.49 | 0.66 | . |
| 480 | 1 | 1 | 3 | 11 | 2 | 20 | 8.0 | 1.87 | 3.94 | 0.60 | 0.79 | . |
| 481 | 1 | 1 | 3 | 11 | 2 | 21 | 8.1 | 1.89 | 4.96 | 0.43 | 0.71 | . |
| 482 | 1 | 1 | 3 | 11 | 2 | 22 | 8.8 | 1.85 | 4.83 | 0.65 | 0.80 | . |
| 483 | 1 | 1 | 3 | 11 | 2 | 23 | 8.6 | 2.12 | 3.56 | 0.66 | 0.69 | . |
| 484 | 1 | 1 | 3 | 11 | 2 | 24 | 8.8 | 1.60 | 5.98 | 0.34 | 0.72 | . |
| 485 | 1 | 1 | 3 | 11 | 2 | 25 | 8.3 | 2.25 | 5.72 | 0.41 | 0.98 | . |
| 486 | 1 | 1 | 3 | 11 | 2 | 26 | 8.9 | 2.01 | 3.18 | 0.64 | 0.95 | . |
| 487 | 1 | 1 | 3 | 11 | 2 | 27 | 9.4 | 2.07 | 5.34 | 0.55 | 0.81 | . |
| 488 | 1 | 1 | 3 | 11 | 2 | 28 | 9.6 | 2.20 | 5.21 | 0.50 | 0.93 | . |
| 489 | 1 | 1 | 3 | 11 | 2 | 29 | 9.3 | 2.30 | 3.82 | 0.60 | 1.08 | . |
| 490 | 1 | 1 | 3 | 11 | 2 | 30 | 9.3 | 1.90 | 3.69 | 0.50 | 0.95 | . |
| 491 | 1 | 1 | 3 | 11 | 2 | 31 | 9.4 | 1.87 | 2.54 | 0.44 | 0.67 | . |
| 492 | 1 | 1 | 3 | 11 | 2 | 32 | 8.3 | 2.11 | 4.20 | 0.48 | 0.68 | . |
| 493 | 1 | 1 | 3 | 11 | 2 | 33 | 9.2 | 1.86 | 3.43 | 0.55 | 1.07 | . |
| 494 | 1 | 1 | 3 | 11 | 2 | 34 | 9.4 | 2.09 | 5.21 | 0.72 | 1.02 | . |
| 495 | 1 | 1 | 3 | 11 | 2 | 35 | 9.1 | 1.89 | 4.32 | 0.41 | 1.09 | . |
| 496 | 1 | 1 | 3 | 11 | 2 | 36 | 8.6 | 2.09 | 4.20 | 0.54 | 0.75 | . |
| 497 | 1 | 1 | 3 | 11 | 2 | 37 | 8.8 | 2.09 | 3.94 | 0.30 | 0.91 | . |
| 498 | 1 | 1 | 3 | 11 | 2 | 38 | 8.4 | 2.03 | 7.50 | 0.47 | 0.95 | . |
| 499 | 1 | 1 | 3 | 11 | 2 | 39 | 9.3 | 2.21 | 4.20 | 0.36 | 0.87 | . |
| 500 | 1 | 1 | 3 | 11 | 2 | 40 | 8.2 | 1.87 | 5.47 | 0.23 | 0.96 | . |
| 501 | 1 | 1 | 3 | 11 | 2 | 41 | 9.0 | 2.07 | 3.18 | 0.59 | 1.08 | . |
| 502 | 1 | 1 | 3 | 11 | 2 | 42 | 8.8 | 1.98 | 5.21 | 0.41 | 0.89 | . |
| 503 | 1 | 1 | 3 | 11 | 2 | 43 | 7.8 | 2.02 | 3.18 | 0.35 | 1.03 | . |
| 504 | 1 | 1 | 3 | 11 | 2 | 44 | 9.1 | 2.03 | 5.21 | 0.54 | 1.15 | . |
| 505 | 1 | 1 | 3 | 11 | 2 | 45 | 8.8 | 2.16 | 3.31 | 0.46 | 1.00 | . |
| 506 | 1 | 1 | 3 | 11 | 2 | 46 | 9.0 | 2.12 | 4.07 | 0.31 | 0.79 | . |
| 507 | 1 | 1 | 3 | 11 | 3 | 1 | 8.7 | 1.91 | 4.27 | 0.70 | 0.69 | . |
| 508 | 1 | 1 | 3 | 11 | 3 | 2 | 8.7 | 1.90 | 3.54 | 0.47 | 0.72 | . |
| 509 | 1 | 1 | 3 | 11 | 3 | 3 | 8.3 | 1.95 | 4.39 | 0.70 | 0.67 | . |
| 510 | 1 | 1 | 3 | 11 | 3 | 4 | 9.1 | 1.91 | 4.76 | 0.78 | 0.77 | . |
| 511 | 1 | 1 | 3 | 11 | 3 | 5 | 8.2 | 1.80 | 3.78 | 0.49 | 0.71 | . |
| 512 | 1 | 1 | 3 | 11 | 3 | 6 | 9.4 | 1.99 | 6.96 | 0.47 | 0.78 | . |
| 513 | 1 | 1 | 3 | 11 | 3 | 7 | 9.3 | 1.95 | 5.49 | 0.66 | 0.64 | . |
| 514 | 1 | 1 | 3 | 11 | 3 | 8 | 8.5 | 1.99 | 4.76 | 0.65 | 0.72 | . |
| 515 | 1 | 1 | 3 | 11 | 3 | 9 | 8.8 | 1.95 | 3.78 | 0.63 | 0.76 | . |
| 516 | 1 | 1 | 3 | 11 | 3 | 10 | 9.1 | 1.85 | 5.74 | 0.55 | 0.45 | . |
| 517 | 1 | 1 | 3 | 11 | 3 | 11 | 9.0 | 1.89 | 3.30 | 0.60 | 0.80 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 518 | 1 | 1 | 3 | 11 | 3 | 12 | 8.7 | 1.91 | 3.78 | 0.53 | 0.91 | . |
| 519 | 1 | 1 | 3 | 11 | 3 | 13 | 7.8 | 1.78 | 3.91 | 0.48 | 0.67 | . |
| 520 | 1 | 1 | 3 | 11 | 3 | 14 | 8.7 | 1.83 | 4.52 | 0.47 | 0.92 | . |
| 521 | 1 | 1 | 3 | 11 | 3 | 15 | 9.0 | 2.20 | 4.64 | 0.45 | 0.56 | . |
| 522 | 1 | 1 | 3 | 11 | 3 | 16 | 8.8 | 1.93 | 2.81 | 0.37 | 0.77 | . |
| 523 | 1 | 1 | 3 | 11 | 3 | 17 | 10.8 | 2.99 | 6.71 | 0.47 | 0.89 | . |
| 524 | 1 | 1 | 3 | 11 | 3 | 18 | 7.8 | 1.97 | 4.15 | 0.43 | 0.94 | . |
| 525 | 1 | 1 | 3 | 11 | 3 | 19 | 9.6 | 2.10 | 2.93 | 0.42 | 0.67 | . |
| 526 | 1 | 1 | 3 | 11 | 3 | 20 | 8.1 | 1.67 | 3.54 | 0.42 | 0.65 | . |
| 527 | 1 | 1 | 3 | 11 | 3 | 21 | 8.3 | 1.95 | 4.88 | 0.29 | 0.67 | . |
| 528 | 1 | 1 | 3 | 11 | 3 | 22 | 7.8 | 1.81 | 3.42 | 0.51 | 0.83 | . |
| 529 | 1 | 1 | 3 | 11 | 3 | 23 | 7.8 | 1.57 | 4.39 | 0.53 | 0.40 | . |
| 530 | 1 | 1 | 3 | 11 | 3 | 24 | 8.7 | 1.69 | 4.52 | 0.55 | 0.55 | . |
| 531 | 1 | 1 | 3 | 11 | 3 | 25 | 8.5 | 1.62 | 4.27 | 0.56 | 0.71 | . |
| 532 | 1 | 1 | 3 | 11 | 3 | 26 | 8.6 | 1.79 | 3.17 | 0.44 | 0.53 | . |
| 533 | 1 | 1 | 3 | 11 | 3 | 27 | 9.7 | 1.90 | 3.66 | 0.64 | 0.63 | . |
| 534 | 1 | 1 | 3 | 11 | 3 | 28 | 8.5 | 1.69 | 4.15 | 0.51 | 0.70 | . |
| 535 | 1 | 1 | 3 | 11 | 3 | 29 | 8.7 | 1.88 | 4.39 | 0.67 | 0.65 | . |
| 536 | 1 | 1 | 3 | 11 | 3 | 30 | 8.7 | 1.96 | 4.52 | 0.50 | 0.83 | . |
| 537 | 1 | 1 | 3 | 11 | 3 | 31 | 8.3 | 1.84 | 3.91 | 0.54 | 0.59 | . |
| 538 | 1 | 1 | 3 | 11 | 3 | 32 | 8.4 | 2.20 | 4.39 | 0.42 | 0.66 | . |
| 539 | 1 | 1 | 3 | 11 | 3 | 33 | 8.2 | 1.71 | 7.81 | 0.30 | 0.54 | . |
| 540 | 1 | 1 | 3 | 11 | 3 | 34 | 8.5 | 1.62 | 2.56 | 0.37 | 0.79 | . |
| 541 | 1 | 1 | 3 | 11 | 3 | 35 | 8.7 | 1.77 | 2.81 | 0.41 | 0.59 | . |
| 542 | 1 | 1 | 3 | 11 | 3 | 36 | 9.1 | 1.88 | 3.78 | 0.58 | 0.40 | . |
| 543 | 1 | 1 | 3 | 11 | 3 | 37 | 7.8 | 1.71 | 4.39 | 0.52 | 0.35 | . |
| 544 | 1 | 1 | 3 | 11 | 3 | 38 | 8.9 | 2.04 | 3.78 | 0.38 | 0.65 | . |
| 545 | 1 | 1 | 3 | 11 | 3 | 39 | 8.9 | 1.74 | 4.15 | 0.59 | 0.62 | . |
| 546 | 1 | 1 | 3 | 11 | 3 | 40 | 8.9 | 1.99 | 4.03 | 0.48 | 0.62 | . |
| 547 | 1 | 1 | 3 | 11 | 3 | 41 | 8.6 | 1.84 | 3.42 | 0.19 | 0.53 | . |
| 548 | 1 | 1 | 3 | 11 | 3 | 42 | 8.6 | 2.08 | 4.39 | 0.46 | 0.77 | . |
| 549 | 1 | 1 | 3 | 11 | 3 | 43 | 9.2 | 2.20 | 4.27 | 0.51 | 0.64 | . |
| 550 | 1 | 1 | 3 | 11 | 3 | 44 | 7.9 | 1.50 | 4.88 | 0.54 | 0.61 | . |
| 551 | 1 | 1 | 3 | 11 | 3 | 45 | 8.1 | 1.74 | 3.30 | 0.52 | 0.65 | . |
| 552 | 1 | 1 | 3 | 11 | 3 | 46 | 8.9 | 1.74 | 2.69 | 0.46 | 0.54 | . |
| 553 | 1 | 1 | 4 | 5 | 1 | 1 | 8.7 | 2.14 | 3.03 | 0.99 | 0.73 | . |
| 554 | 1 | 1 | 4 | 5 | 1 | 2 | 9.9 | 2.42 | 1.94 | 3.65 | 0.73 | . |
| 555 | 1 | 1 | 4 | 5 | 1 | 3 | 9.2 | 2.53 | 3.87 | 0.84 | 0.80 | . |
| 556 | 1 | 1 | 4 | 5 | 1 | 4 | 9.5 | 2.44 | 2.18 | 0.55 | 0.21 | . |
| 557 | 1 | 1 | 4 | 5 | 1 | 5 | 9.6 | 2.56 | 2.91 | 0.46 | 0.40 | . |
| 558 | 1 | 1 | 4 | 5 | 1 | 6 | 8.2 | 2.43 | 2.18 | 0.43 | 0.68 | . |
| 559 | 1 | 1 | 4 | 5 | 1 | 7 | 9.4 | 2.61 | 3.75 | 0.54 | 0.61 | . |
| 560 | 1 | 1 | 4 | 5 | 1 | 8 | 8.9 | 2.93 | 1.57 | 0.50 | 0.70 | . |
| 561 | 1 | 1 | 4 | 5 | 1 | 9 | 7.7 | 2.62 | 7.38 | 0.80 | 0.57 | . |
| 562 | 1 | 1 | 4 | 5 | 1 | 10 | 7.4 | 2.58 | 9.32 | 0.42 | 0.64 | . |
| 563 | 1 | 1 | 4 | 5 | 1 | 11 | 8.7 | 2.35 | 7.51 | 0.32 | 0.82 | . |
| 564 | 1 | 1 | 4 | 5 | 1 | 12 | 8.0 | 2.37 | 7.38 | 0.45 | 0.82 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 565 | 1 | 1 | 4 | 5 | 1 | 13 | 7.4 | 2.43 | 7.75 | 0.17 | 0.59 | . |
| 566 | 1 | 1 | 4 | 5 | 1 | 14 | 7.7 | 2.46 | 1.94 | 0.60 | 0.76 | . |
| 567 | 1 | 1 | 4 | 5 | 1 | 15 | 10.0 | 1.92 | 2.91 | 0.67 | 0.75 | . |
| 568 | 1 | 1 | 4 | 5 | 1 | 16 | 9.7 | 1.93 | 4.24 | 0.82 | 0.82 | . |
| 569 | 1 | 1 | 4 | 5 | 1 | 17 | 10.3 | 2.47 | 2.18 | 0.46 | 0.68 | . |
| 570 | 1 | 1 | 4 | 5 | 1 | 18 | 9.8 | 2.23 | 2.06 | 0.77 | 0.82 | . |
| 571 | 1 | 1 | 4 | 5 | 1 | 19 | 9.9 | 2.03 | 1.45 | 0.81 | 0.75 | . |
| 572 | 1 | 1 | 4 | 5 | 1 | 20 | 9.9 | 2.14 | 1.45 | 0.88 | 0.65 | . |
| 573 | 1 | 1 | 4 | 5 | 1 | 21 | 9.5 | 2.46 | 3.39 | 0.78 | 0.98 | . |
| 574 | 1 | 1 | 4 | 5 | 1 | 22 | 9.3 | 2.16 | 1.57 | 0.78 | 0.98 | . |
| 575 | 1 | 1 | 4 | 5 | 1 | 23 | 9.9 | 2.13 | 1.82 | 0.75 | 0.88 | . |
| 576 | 1 | 1 | 4 | 5 | 1 | 24 | 8.4 | 2.40 | 1.45 | 0.45 | 0.76 | . |
| 577 | 1 | 1 | 4 | 5 | 1 | 25 | 8.3 | 2.37 | 1.82 | 1.62 | 1.10 | . |
| 578 | 1 | 1 | 4 | 5 | 1 | 26 | 8.0 | 2.67 | 2.42 | 0.73 | 1.11 | . |
| 579 | 1 | 1 | 4 | 5 | 1 | 27 | 8.8 | 2.66 | 1.82 | 0.57 | 0.89 | . |
| 580 | 1 | 1 | 4 | 5 | 1 | 28 | 9.5 | 2.61 | 7.14 | 1.16 | 0.69 | . |
| 581 | 1 | 1 | 4 | 5 | 1 | 29 | 8.7 | 2.84 | 8.47 | 0.29 | 0.90 | . |
| 582 | 1 | 1 | 4 | 5 | 1 | 30 | 10.4 | 2.22 | 8.47 | 3.13 | 0.79 | . |
| 583 | 1 | 1 | 4 | 5 | 1 | 31 | 9.2 | 2.48 | 7.14 | 0.59 | 0.98 | . |
| 584 | 1 | 1 | 4 | 5 | 1 | 32 | 9.5 | 2.75 | 6.78 | 0.38 | 0.74 | . |
| 585 | 1 | 1 | 4 | 5 | 1 | 33 | 7.5 | 2.19 | 7.51 | 0.28 | 0.78 | . |
| 586 | 1 | 1 | 4 | 5 | 1 | 34 | 9.0 | 2.50 | 3.15 | 0.61 | 0.93 | . |
| 587 | 1 | 1 | 4 | 5 | 1 | 35 | 11.0 | 2.47 | 7.38 | 0.84 | 0.97 | . |
| 588 | 1 | 1 | 4 | 5 | 1 | 36 | 10.2 | 2.92 | 7.63 | 0.99 | 0.86 | . |
| 589 | 1 | 1 | 4 | 5 | 1 | 37 | 9.3 | 2.29 | 3.15 | 0.44 | 0.73 | . |
| 590 | 1 | 1 | 4 | 5 | 1 | 38 | 10.2 | 2.21 | 1.94 | 1.32 | 1.00 | . |
| 591 | 1 | 1 | 4 | 5 | 1 | 39 | 9.5 | 2.19 | 2.18 | 0.89 | 1.07 | . |
| 592 | 1 | 1 | 4 | 5 | 1 | 40 | 10.3 | 2.28 | 2.42 | 0.81 | 0.97 | . |
| 593 | 1 | 1 | 4 | 5 | 1 | 41 | 9.7 | 2.29 | 1.45 | 0.81 | 1.24 | . |
| 594 | 1 | 1 | 4 | 5 | 1 | 42 | 9.6 | 2.41 | 2.06 | 0.77 | 1.13 | . |
| 595 | 1 | 1 | 4 | 5 | 1 | 43 | 7.6 | 2.36 | 2.78 | 0.46 | 0.73 | . |
| 596 | 1 | 1 | 4 | 5 | 1 | 44 | 9.3 | 2.13 | 3.15 | 0.56 | 1.65 | . |
| 597 | 1 | 1 | 4 | 5 | 1 | 45 | 10.0 | 2.15 | 1.33 | 0.82 | 0.88 | . |
| 598 | 1 | 1 | 4 | 5 | 1 | 46 | 10.7 | 2.67 | 2.30 | 0.74 | 0.87 | . |
| 599 | 1 | 1 | 4 | 5 | 2 | 1 | 9.5 | 2.62 | 3.28 | 0.76 | 0.83 | . |
| 600 | 1 | 1 | 4 | 5 | 2 | 2 | 13.3 | 2.97 | 2.31 | 0.83 | 1.09 | . |
| 601 | 1 | 1 | 4 | 5 | 2 | 3 | 8.8 | 2.28 | 1.94 | 0.52 | 0.90 | . |
| 602 | 1 | 1 | 4 | 5 | 2 | 4 | 9.7 | 2.13 | 2.79 | 0.55 | 0.95 | . |
| 603 | 1 | 1 | 4 | 5 | 2 | 5 | 9.6 | 2.57 | 1.58 | 0.66 | 0.77 | . |
| 604 | 1 | 1 | 4 | 5 | 2 | 6 | 9.7 | 2.47 | 1.70 | 0.54 | 0.83 | . |
| 605 | 1 | 1 | 4 | 5 | 2 | 7 | 7.9 | 1.99 | 1.82 | 0.47 | 0.87 | . |
| 606 | 1 | 1 | 4 | 5 | 2 | 8 | 9.9 | 2.56 | 2.31 | 0.60 | 0.99 | . |
| 607 | 1 | 1 | 4 | 5 | 2 | 9 | 8.8 | 1.99 | 2.06 | 0.57 | 0.84 | . |
| 608 | 1 | 1 | 4 | 5 | 2 | 10 | 9.1 | 2.07 | 1.46 | 0.36 | 0.74 | . |
| 609 | 1 | 1 | 4 | 5 | 2 | 11 | 8.8 | 2.40 | 1.21 | 0.49 | 0.58 | . |
| 610 | 1 | 1 | 4 | 5 | 2 | 12 | 10.1 | 3.04 | 2.79 | 0.65 | 0.86 | . |
| 611 | 1 | 1 | 4 | 5 | 2 | 13 | 9.4 | 2.15 | 2.18 | 0.62 | 0.90 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 612 | 1 | 1 | 4 | 5 | 2 | 14 | 9.7 | 2.46 | 2.79 | 0.42 | 0.78 | . |
| 613 | 1 | 1 | 4 | 5 | 2 | 15 | 9.8 | 2.12 | 2.31 | 0.43 | 0.91 | . |
| 614 | 1 | 1 | 4 | 5 | 2 | 16 | 9.3 | 2.66 | 3.52 | 0.59 | 0.97 | . |
| 615 | 1 | 1 | 4 | 5 | 2 | 17 | 10.5 | 2.39 | 1.94 | 0.48 | 0.96 | . |
| 616 | 1 | 1 | 4 | 5 | 2 | 18 | 9.0 | 2.41 | 1.33 | 0.40 | 0.80 | . |
| 617 | 1 | 1 | 4 | 5 | 2 | 19 | 9.4 | 2.17 | 2.06 | 0.58 | 0.99 | . |
| 618 | 1 | 1 | 4 | 5 | 2 | 20 | 10.2 | 2.60 | 1.70 | 0.47 | 0.85 | . |
| 619 | 1 | 1 | 4 | 5 | 2 | 21 | 9.6 | 2.16 | 2.43 | 0.40 | 1.33 | . |
| 620 | 1 | 1 | 4 | 5 | 2 | 22 | 9.6 | 2.67 | 3.88 | 0.42 | 0.91 | . |
| 621 | 1 | 1 | 4 | 5 | 2 | 23 | 8.7 | 2.02 | 2.18 | 0.53 | 0.85 | . |
| 622 | 1 | 1 | 4 | 5 | 2 | 24 | 8.3 | 2.10 | 1.46 | 0.59 | 0.85 | . |
| 623 | 1 | 1 | 4 | 5 | 2 | 25 | 9.6 | 2.34 | 2.43 | 0.33 | 0.88 | . |
| 624 | 1 | 1 | 4 | 5 | 2 | 26 | 10.5 | 2.79 | 2.31 | 0.59 | 0.89 | . |
| 625 | 1 | 1 | 4 | 5 | 2 | 27 | 9.3 | 2.46 | 3.15 | 0.24 | 0.59 | . |
| 626 | 1 | 1 | 4 | 5 | 2 | 28 | 9.0 | 2.51 | 1.21 | 0.60 | 0.52 | . |
| 627 | 1 | 1 | 4 | 5 | 2 | 29 | 8.4 | 2.25 | 2.31 | 0.21 | 0.82 | . |
| 628 | 1 | 1 | 4 | 5 | 2 | 30 | 9.3 | 2.48 | 3.28 | 0.54 | 0.69 | . |
| 629 | 1 | 1 | 4 | 5 | 2 | 31 | 8.1 | 2.64 | 1.82 | 0.34 | 0.82 | . |
| 630 | 1 | 1 | 4 | 5 | 2 | 32 | 7.5 | 1.85 | 2.06 | 0.32 | 0.82 | . |
| 631 | 1 | 1 | 4 | 5 | 2 | 33 | 8.7 | 2.62 | 1.70 | 0.32 | 0.70 | . |
| 632 | 1 | 1 | 4 | 5 | 2 | 34 | 9.1 | 2.49 | 1.09 | 0.35 | 0.96 | . |
| 633 | 1 | 1 | 4 | 5 | 2 | 35 | 9.3 | 2.35 | 1.70 | 0.17 | 0.68 | . |
| 634 | 1 | 1 | 4 | 5 | 2 | 36 | 9.5 | 2.73 | 1.09 | 0.17 | 0.94 | . |
| 635 | 1 | 1 | 4 | 5 | 2 | 37 | 10.2 | 2.50 | 3.40 | 0.65 | 1.19 | . |
| 636 | 1 | 1 | 4 | 5 | 2 | 38 | 7.0 | 1.92 | 1.21 | 0.18 | 0.89 | . |
| 637 | 1 | 1 | 4 | 5 | 2 | 39 | 9.0 | 2.37 | 3.64 | 0.47 | 0.76 | . |
| 638 | 1 | 1 | 4 | 5 | 2 | 40 | 9.5 | 2.28 | 2.18 | 0.06 | 0.92 | . |
| 639 | 1 | 1 | 4 | 5 | 2 | 41 | 9.4 | 2.18 | 1.94 | 0.39 | 0.70 | . |
| 640 | 1 | 1 | 4 | 5 | 2 | 42 | 9.1 | 2.57 | 1.82 | 0.30 | 0.79 | . |
| 641 | 1 | 1 | 4 | 5 | 2 | 43 | 9.5 | 2.13 | 1.94 | 0.21 | 0.99 | . |
| 642 | 1 | 1 | 4 | 5 | 2 | 44 | 9.6 | 2.76 | 2.79 | 0.13 | 0.87 | . |
| 643 | 1 | 1 | 4 | 5 | 2 | 45 | 9.1 | 2.54 | 1.70 | 0.64 | 0.76 | . |
| 644 | 1 | 1 | 4 | 5 | 2 | 46 | 9.0 | 2.06 | 0.85 | 0.06 | 1.10 | . |
| 645 | 1 | 1 | 4 | 5 | 3 | 1 | 9.5 | 1.64 | 4.25 | 0.57 | 1.17 | . |
| 646 | 1 | 1 | 4 | 5 | 3 | 2 | 10.3 | 2.02 | 4.62 | 0.71 | 0.92 | . |
| 647 | 1 | 1 | 4 | 5 | 3 | 3 | 9.5 | 1.53 | 3.65 | 0.38 | 0.66 | . |
| 648 | 1 | 1 | 4 | 5 | 3 | 4 | 9.6 | 1.32 | 3.28 | 0.30 | 1.15 | . |
| 649 | 1 | 1 | 4 | 5 | 3 | 5 | 10.4 | 2.01 | 5.84 | 0.62 | 0.92 | . |
| 650 | 1 | 1 | 4 | 5 | 3 | 6 | 9.3 | 1.54 | 4.62 | 0.38 | 0.79 | . |
| 651 | 1 | 1 | 4 | 5 | 3 | 7 | 9.4 | 1.90 | 3.77 | 0.69 | 0.66 | . |
| 652 | 1 | 1 | 4 | 5 | 3 | 8 | 10.5 | 1.76 | 4.50 | 0.70 | 0.79 | . |
| 653 | 1 | 1 | 4 | 5 | 3 | 9 | 9.8 | 1.93 | 5.11 | 0.55 | 1.15 | . |
| 654 | 1 | 1 | 4 | 5 | 3 | 10 | 9.1 | 1.80 | 3.89 | 0.34 | 0.92 | . |
| 655 | 1 | 1 | 4 | 5 | 3 | 11 | 10.4 | 1.88 | 6.08 | 0.42 | 1.25 | . |
| 656 | 1 | 1 | 4 | 5 | 3 | 12 | 9.7 | 1.65 | 4.86 | 1.20 | 0.99 | . |
| 657 | 1 | 1 | 4 | 5 | 3 | 13 | 9.6 | 1.98 | 2.80 | 0.28 | 0.78 | . |
| 658 | 1 | 1 | 4 | 5 | 3 | 14 | 9.9 | 1.85 | 3.77 | 0.47 | 1.24 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 659 | 1 | 1 | 4 | 5 | 3 | 15 | 10.9 | 1.79 | 3.77 | 0.12 | 0.81 | . |
| 660 | 1 | 1 | 4 | 5 | 3 | 16 | 10.1 | 2.12 | 5.71 | 0.74 | 1.19 | . |
| 661 | 1 | 1 | 4 | 5 | 3 | 17 | 9.9 | 1.85 | 6.93 | 0.62 | 0.70 | . |
| 662 | 1 | 1 | 4 | 5 | 3 | 18 | 9.7 | 1.62 | 4.25 | 0.24 | 0.80 | . |
| 663 | 1 | 1 | 4 | 5 | 3 | 19 | 10.5 | 1.92 | 3.77 | 0.39 | 0.92 | . |
| 664 | 1 | 1 | 4 | 5 | 3 | 20 | 9.2 | 1.57 | 4.25 | 0.49 | 0.80 | . |
| 665 | 1 | 1 | 4 | 5 | 3 | 21 | 9.4 | 1.66 | 4.50 | 0.24 | 1.02 | . |
| 666 | 1 | 1 | 4 | 5 | 3 | 22 | 8.7 | 1.32 | 3.53 | 0.68 | 0.96 | . |
| 667 | 1 | 1 | 4 | 5 | 3 | 23 | 9.3 | 1.85 | 3.16 | 1.21 | 0.84 | . |
| 668 | 1 | 1 | 4 | 5 | 3 | 24 | 9.2 | 1.68 | 3.40 | 0.48 | 0.81 | . |
| 669 | 1 | 1 | 4 | 5 | 3 | 25 | 10.6 | 1.92 | 4.25 | 0.53 | 0.57 | . |
| 670 | 1 | 1 | 4 | 5 | 3 | 26 | 10.9 | 1.80 | 3.53 | 0.74 | 0.98 | . |
| 671 | 1 | 1 | 4 | 5 | 3 | 27 | 10.8 | 1.71 | 4.50 | 0.97 | 0.65 | . |
| 672 | 1 | 1 | 4 | 5 | 3 | 28 | 9.5 | 1.55 | 3.65 | 0.54 | 0.77 | . |
| 673 | 1 | 1 | 4 | 5 | 3 | 29 | 9.7 | 1.46 | 5.23 | 0.52 | 1.35 | . |
| 674 | 1 | 1 | 4 | 5 | 3 | 30 | 10.4 | 1.62 | 3.77 | 0.57 | 1.00 | . |
| 675 | 1 | 1 | 4 | 5 | 3 | 31 | 10.7 | 1.65 | 5.96 | 0.80 | 0.96 | . |
| 676 | 1 | 1 | 4 | 5 | 3 | 32 | 10.0 | 1.59 | 3.40 | 0.46 | 0.70 | . |
| 677 | 1 | 1 | 4 | 5 | 3 | 33 | 9.9 | 1.95 | 3.53 | 0.57 | 0.96 | . |
| 678 | 1 | 1 | 4 | 5 | 3 | 34 | 11.1 | 1.72 | 6.44 | 0.34 | 1.05 | . |
| 679 | 1 | 1 | 4 | 5 | 3 | 35 | 9.6 | 1.70 | 4.01 | 0.48 | 0.98 | . |
| 680 | 1 | 1 | 4 | 5 | 3 | 36 | 10.4 | 1.61 | 4.50 | 0.56 | 0.97 | . |
| 681 | 1 | 1 | 4 | 5 | 3 | 37 | 10.7 | 1.83 | 5.84 | 0.72 | 0.68 | . |
| 682 | 1 | 1 | 4 | 5 | 3 | 38 | 9.0 | 1.71 | 4.01 | 0.22 | 1.05 | . |
| 683 | 1 | 1 | 4 | 5 | 3 | 39 | 9.8 | 1.66 | 4.38 | 0.55 | 0.98 | . |
| 684 | 1 | 1 | 4 | 5 | 3 | 40 | 10.0 | 1.85 | 4.86 | 0.60 | 0.98 | . |
| 685 | 1 | 1 | 4 | 5 | 3 | 41 | 10.5 | 2.26 | 2.19 | 0.38 | 1.09 | . |
| 686 | 1 | 1 | 4 | 5 | 3 | 42 | 11.1 | 1.90 | 4.74 | 0.35 | 0.84 | . |
| 687 | 1 | 1 | 4 | 5 | 3 | 43 | 9.2 | 1.61 | 3.89 | 0.22 | 1.14 | . |
| 688 | 1 | 1 | 4 | 5 | 3 | 44 | 10.5 | 1.67 | 5.84 | 0.76 | 0.87 | . |
| 689 | 1 | 1 | 4 | 5 | 3 | 45 | 9.1 | 1.55 | 4.50 | 0.20 | 0.80 | . |
| 690 | 1 | 1 | 4 | 5 | 3 | 46 | 10.9 | 2.08 | 5.71 | 0.51 | 1.09 | . |
| 691 | 1 | 1 | 4 | 11 | 1 | 1 | 9.4 | 1.81 | 7.15 | 0.56 | 0.79 | . |
| 692 | 1 | 1 | 4 | 11 | 1 | 2 | 9.7 | 1.75 | 5.21 | 0.56 | 0.86 | . |
| 693 | 1 | 1 | 4 | 11 | 1 | 3 | 10.6 | 1.61 | 5.45 | 0.53 | 0.97 | . |
| 694 | 1 | 1 | 4 | 11 | 1 | 4 | 8.5 | 1.60 | 6.54 | 0.29 | 0.90 | . |
| 695 | 1 | 1 | 4 | 11 | 1 | 5 | 10.0 | 1.90 | 4.36 | 0.52 | 1.01 | . |
| 696 | 1 | 1 | 4 | 11 | 1 | 6 | 9.9 | 1.88 | 3.88 | 0.32 | 0.82 | . |
| 697 | 1 | 1 | 4 | 11 | 1 | 7 | 8.7 | 1.58 | 6.42 | 0.46 | 0.76 | . |
| 698 | 1 | 1 | 4 | 11 | 1 | 8 | 9.2 | 1.66 | 6.79 | 0.24 | 0.73 | . |
| 699 | 1 | 1 | 4 | 11 | 1 | 9 | 8.2 | 1.36 | 4.73 | 0.31 | 0.89 | . |
| 700 | 1 | 1 | 4 | 11 | 1 | 10 | 8.8 | 1.69 | 6.06 | 0.37 | 0.87 | . |
| 701 | 1 | 1 | 4 | 11 | 1 | 11 | 8.0 | 1.93 | 4.48 | 0.47 | 0.77 | . |
| 702 | 1 | 1 | 4 | 11 | 1 | 12 | 10.8 | 2.15 | 6.91 | 0.39 | 1.02 | . |
| 703 | 1 | 1 | 4 | 11 | 1 | 13 | 8.9 | 1.54 | 5.57 | 0.22 | 1.18 | . |
| 704 | 1 | 1 | 4 | 11 | 1 | 14 | 10.3 | 1.67 | 4.73 | 0.25 | 1.09 | . |
| 705 | 1 | 1 | 4 | 11 | 1 | 15 | 9.7 | 1.56 | 4.73 | 0.25 | 0.87 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 706 | 1 | 1 | 4 | 11 | 1 | 16 | 9.2 | 1.69 | 6.06 | 0.33 | 1.00 | . |
| 707 | 1 | 1 | 4 | 11 | 1 | 17 | 9.8 | 1.63 | 4.48 | 0.22 | 0.85 | . |
| 708 | 1 | 1 | 4 | 11 | 1 | 18 | 10.0 | 1.76 | 4.12 | 0.47 | 1.13 | . |
| 709 | 1 | 1 | 4 | 11 | 1 | 19 | 9.9 | 1.54 | 4.48 | 0.23 | 0.52 | . |
| 710 | 1 | 1 | 4 | 11 | 1 | 20 | 9.1 | 1.87 | 5.21 | 0.47 | 0.91 | . |
| 711 | 1 | 1 | 4 | 11 | 1 | 21 | 10.0 | 1.78 | 4.24 | 0.78 | 0.86 | . |
| 712 | 1 | 1 | 4 | 11 | 1 | 22 | 9.3 | 1.60 | 5.45 | 0.55 | 1.20 | . |
| 713 | 1 | 1 | 4 | 11 | 1 | 23 | 9.1 | 1.74 | 5.09 | 0.56 | 0.79 | . |
| 714 | 1 | 1 | 4 | 11 | 1 | 24 | 11.4 | 1.85 | 5.94 | 0.77 | 0.93 | . |
| 715 | 1 | 1 | 4 | 11 | 1 | 25 | 11.5 | 2.02 | 6.54 | 0.60 | 1.21 | . |
| 716 | 1 | 1 | 4 | 11 | 1 | 26 | 10.2 | 1.83 | 5.21 | 0.52 | 1.01 | . |
| 717 | 1 | 1 | 4 | 11 | 1 | 27 | 9.4 | 1.64 | 5.33 | 0.47 | 1.00 | . |
| 718 | 1 | 1 | 4 | 11 | 1 | 28 | 9.8 | 1.83 | 5.45 | 0.40 | 0.79 | . |
| 719 | 1 | 1 | 4 | 11 | 1 | 29 | 8.5 | 1.74 | 5.21 | 0.42 | 0.83 | . |
| 720 | 1 | 1 | 4 | 11 | 1 | 30 | 10.2 | 1.82 | 5.45 | 0.57 | 1.04 | . |
| 721 | 1 | 1 | 4 | 11 | 1 | 31 | 10.0 | 1.73 | 4.85 | 0.43 | 1.06 | . |
| 722 | 1 | 1 | 4 | 11 | 1 | 32 | 8.2 | 1.29 | 5.33 | 0.25 | 0.88 | . |
| 723 | 1 | 1 | 4 | 11 | 1 | 33 | 9.0 | 1.51 | 5.33 | 0.20 | 1.06 | . |
| 724 | 1 | 1 | 4 | 11 | 1 | 34 | 9.1 | 1.60 | 4.12 | 0.55 | 0.71 | . |
| 725 | 1 | 1 | 4 | 11 | 1 | 35 | 10.8 | 1.84 | 3.88 | 0.62 | 1.37 | . |
| 726 | 1 | 1 | 4 | 11 | 1 | 36 | 10.0 | 1.84 | 7.03 | 0.44 | 1.15 | . |
| 727 | 1 | 1 | 4 | 11 | 1 | 37 | 8.7 | 1.80 | 5.45 | 0.36 | 0.85 | . |
| 728 | 1 | 1 | 4 | 11 | 1 | 38 | 9.3 | 1.91 | 4.24 | 0.51 | 0.97 | . |
| 729 | 1 | 1 | 4 | 11 | 1 | 39 | 10.2 | 1.92 | 5.09 | 1.60 | 0.77 | . |
| 730 | 1 | 1 | 4 | 11 | 1 | 40 | 9.0 | 1.70 | 3.51 | 0.40 | 1.03 | . |
| 731 | 1 | 1 | 4 | 11 | 1 | 41 | 11.7 | 1.91 | 6.67 | 0.64 | 1.20 | . |
| 732 | 1 | 1 | 4 | 11 | 1 | 42 | 9.5 | 1.87 | 4.85 | 0.46 | 1.02 | . |
| 733 | 1 | 1 | 4 | 11 | 1 | 43 | 8.6 | 1.68 | 4.73 | 0.41 | 0.99 | . |
| 734 | 1 | 1 | 4 | 11 | 1 | 44 | 9.5 | 1.71 | 6.18 | 0.39 | 0.83 | . |
| 735 | 1 | 1 | 4 | 11 | 1 | 45 | 9.7 | 1.48 | 6.54 | 0.36 | 1.09 | . |
| 736 | 1 | 1 | 4 | 11 | 1 | 46 | 11.2 | 2.28 | 5.09 | 0.45 | 1.05 | . |
| 737 | 1 | 1 | 4 | 11 | 2 | 1 | 8.7 | 2.12 | 3.03 | 0.46 | 0.17 | . |
| 738 | 1 | 1 | 4 | 11 | 2 | 2 | 8.9 | 1.84 | 6.18 | 0.27 | 1.05 | . |
| 739 | 1 | 1 | 4 | 11 | 2 | 3 | 9.5 | 2.11 | 3.76 | 0.55 | 1.41 | . |
| 740 | 1 | 1 | 4 | 11 | 2 | 4 | 8.3 | 1.93 | 2.54 | 0.45 | 0.96 | . |
| 741 | 1 | 1 | 4 | 11 | 2 | 5 | 9.3 | 2.00 | 4.00 | 0.45 | 0.62 | . |
| 742 | 1 | 1 | 4 | 11 | 2 | 6 | 8.5 | 1.73 | 3.88 | 0.29 | 1.09 | . |
| 743 | 1 | 1 | 4 | 11 | 2 | 7 | 8.5 | 1.91 | 3.76 | 0.41 | 1.22 | . |
| 744 | 1 | 1 | 4 | 11 | 2 | 8 | 9.1 | 1.92 | 4.36 | 0.54 | 0.94 | . |
| 745 | 1 | 1 | 4 | 11 | 2 | 9 | 9.4 | 2.19 | 3.64 | 0.40 | 0.86 | . |
| 746 | 1 | 1 | 4 | 11 | 2 | 10 | 8.2 | 2.29 | 4.36 | 0.31 | 1.03 | . |
| 747 | 1 | 1 | 4 | 11 | 2 | 11 | 8.7 | 1.97 | 3.03 | 0.50 | 1.18 | . |
| 748 | 1 | 1 | 4 | 11 | 2 | 12 | 7.9 | 1.97 | 4.12 | 0.51 | 0.93 | . |
| 749 | 1 | 1 | 4 | 11 | 2 | 13 | 8.5 | 1.68 | 4.97 | 0.27 | 0.85 | . |
| 750 | 1 | 1 | 4 | 11 | 2 | 14 | 10.0 | 2.44 | 2.30 | 0.76 | 2.08 | . |
| 751 | 1 | 1 | 4 | 11 | 2 | 15 | 9.4 | 1.93 | 5.57 | 0.49 | 1.30 | . |
| 752 | 1 | 1 | 4 | 11 | 2 | 16 | 8.4 | 1.86 | 7.39 | 0.35 | 1.31 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 753 | 1 | 1 | 4 | 11 | 2 | 17 | 8.5 | 2.14 | 3.51 | 0.54 | 1.37 | . |
| 754 | 1 | 1 | 4 | 11 | 2 | 18 | 8.0 | 1.90 | 7.51 | 0.37 | 2.12 | . |
| 755 | 1 | 1 | 4 | 11 | 2 | 19 | 9.4 | 2.22 | 4.00 | 0.35 | 1.73 | . |
| 756 | 1 | 1 | 4 | 11 | 2 | 20 | 7.8 | 1.91 | 4.48 | 0.20 | 1.67 | . |
| 757 | 1 | 1 | 4 | 11 | 2 | 21 | 11.0 | 3.04 | 4.73 | 0.48 | 1.60 | . |
| 758 | 1 | 1 | 4 | 11 | 2 | 22 | 9.2 | 2.08 | 5.57 | 0.56 | 0.30 | . |
| 759 | 1 | 1 | 4 | 11 | 2 | 23 | 9.2 | 1.94 | 5.09 | 0.57 | 0.00 | . |
| 760 | 1 | 1 | 4 | 11 | 2 | 24 | 8.9 | 1.84 | 3.64 | 0.28 | 0.00 | . |
| 761 | 1 | 1 | 4 | 11 | 2 | 25 | 9.2 | 2.26 | 3.39 | 0.43 | 0.50 | . |
| 762 | 1 | 1 | 4 | 11 | 2 | 26 | 9.5 | 2.22 | 3.88 | 0.78 | 0.00 | . |
| 763 | 1 | 1 | 4 | 11 | 2 | 27 | 10.5 | 2.61 | 3.51 | 0.62 | 0.90 | . |
| 764 | 1 | 1 | 4 | 11 | 2 | 28 | 9.9 | 2.54 | 3.03 | 0.48 | 0.40 | . |
| 765 | 1 | 1 | 4 | 11 | 2 | 29 | 9.1 | 2.25 | 2.91 | 0.40 | 0.30 | . |
| 766 | 1 | 1 | 4 | 11 | 2 | 30 | 6.7 | 2.15 | 4.00 | 0.34 | 0.00 | . |
| 767 | 1 | 1 | 4 | 11 | 2 | 31 | 9.3 | 1.64 | 4.00 | 0.36 | 0.20 | . |
| 768 | 1 | 1 | 4 | 11 | 2 | 32 | 8.8 | 2.42 | 6.42 | 0.31 | 0.30 | . |
| 769 | 1 | 1 | 4 | 11 | 2 | 33 | 9.0 | 2.12 | 4.60 | 0.38 | 0.10 | . |
| 770 | 1 | 1 | 4 | 11 | 2 | 34 | 10.4 | 2.28 | 4.12 | 0.54 | 0.90 | . |
| 771 | 1 | 1 | 4 | 11 | 2 | 35 | 8.6 | 2.02 | 3.39 | 0.30 | 0.70 | . |
| 772 | 1 | 1 | 4 | 11 | 2 | 36 | 9.1 | 2.25 | 4.85 | 0.63 | 0.80 | . |
| 773 | 1 | 1 | 4 | 11 | 2 | 37 | 9.8 | 2.32 | 3.51 | 0.71 | 0.50 | . |
| 774 | 1 | 1 | 4 | 11 | 2 | 38 | 10.5 | 2.72 | 5.70 | 0.60 | 0.20 | . |
| 775 | 1 | 1 | 4 | 11 | 2 | 39 | 8.1 | 2.17 | 5.33 | 0.32 | 0.50 | . |
| 776 | 1 | 1 | 4 | 11 | 2 | 40 | 9.4 | 2.42 | 5.45 | 0.55 | 0.50 | . |
| 777 | 1 | 1 | 4 | 11 | 2 | 41 | 9.3 | 2.12 | 4.73 | 0.24 | 0.80 | . |
| 778 | 1 | 1 | 4 | 11 | 2 | 42 | 9.4 | 2.24 | 3.64 | 0.64 | 0.60 | . |
| 779 | 1 | 1 | 4 | 11 | 2 | 43 | 8.6 | 2.18 | 4.12 | 0.32 | 1.30 | . |
| 780 | 1 | 1 | 4 | 11 | 2 | 44 | 8.7 | 2.27 | 4.00 | 0.37 | 0.40 | . |
| 781 | 1 | 1 | 4 | 11 | 2 | 45 | 8.8 | 2.27 | 3.39 | 0.63 | 1.10 | . |
| 782 | 1 | 1 | 4 | 11 | 2 | 46 | 8.7 | 1.90 | 3.76 | 0.43 | 0.00 | . |
| 783 | 1 | 1 | 4 | 11 | 3 | 1 | 8.3 | 2.08 | 2.30 | 0.53 | 0.58 | . |
| 784 | 1 | 1 | 4 | 11 | 3 | 2 | 9.3 | 1.60 | 2.67 | 0.31 | 1.13 | . |
| 785 | 1 | 1 | 4 | 11 | 3 | 3 | 9.7 | 1.74 | 3.64 | 0.57 | 0.97 | . |
| 786 | 1 | 1 | 4 | 11 | 3 | 4 | 10.9 | 2.44 | 3.39 | 0.60 | 1.29 | . |
| 787 | 1 | 1 | 4 | 11 | 3 | 5 | 4.6 | 1.15 | 2.06 | 0.30 | 0.50 | . |
| 788 | 1 | 1 | 4 | 11 | 3 | 6 | 10.2 | 2.22 | 3.88 | 0.81 | 0.92 | . |
| 789 | 1 | 1 | 4 | 11 | 3 | 7 | 8.0 | 1.69 | 3.51 | 0.53 | 0.78 | . |
| 790 | 1 | 1 | 4 | 11 | 3 | 8 | 8.8 | 2.14 | 2.91 | 0.69 | 1.25 | . |
| 791 | 1 | 1 | 4 | 11 | 3 | 9 | 9.2 | 2.13 | 3.15 | 0.48 | 0.97 | . |
| 792 | 1 | 1 | 4 | 11 | 3 | 10 | 8.9 | 2.15 | 2.18 | 0.43 | 1.33 | . |
| 793 | 1 | 1 | 4 | 11 | 3 | 11 | 8.7 | 2.07 | 2.91 | 0.58 | 1.09 | . |
| 794 | 1 | 1 | 4 | 11 | 3 | 12 | 8.0 | 1.60 | 2.30 | 0.61 | 1.01 | . |
| 795 | 1 | 1 | 4 | 11 | 3 | 13 | 8.8 | 1.96 | 4.12 | 0.38 | 8.20 | . |
| 796 | 1 | 1 | 4 | 11 | 3 | 14 | 9.2 | 1.84 | 2.42 | 0.48 | 0.54 | . |
| 797 | 1 | 1 | 4 | 11 | 3 | 15 | 9.2 | 1.78 | 3.39 | 0.58 | 0.91 | . |
| 798 | 1 | 1 | 4 | 11 | 3 | 16 | 9.7 | 2.11 | 2.30 | 0.37 | 0.92 | . |
| 799 | 1 | 1 | 4 | 11 | 3 | 17 | 9.0 | 1.96 | 2.30 | 0.53 | 0.94 | . |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 800 | 1 | 1 | 4 | 11 | 3 | 18 | 10.8 | 2.44 | 3.64 | 0.57 | 0.79 | . |
| 801 | 1 | 1 | 4 | 11 | 3 | 19 | 9.9 | 2.50 | 3.76 | 0.73 | 0.91 | . |
| 802 | 1 | 1 | 4 | 11 | 3 | 20 | 7.5 | 1.59 | 2.06 | 0.34 | 0.77 | . |
| 803 | 1 | 1 | 4 | 11 | 3 | 21 | 10.8 | 2.60 | 4.85 | 0.56 | 0.76 | . |
| 804 | 1 | 1 | 4 | 11 | 3 | 22 | 7.1 | 1.94 | 1.94 | 0.35 | 0.78 | . |
| 805 | 1 | 1 | 4 | 11 | 3 | 23 | 10.2 | 2.69 | 3.03 | 0.66 | 1.53 | . |
| 806 | 1 | 1 | 4 | 11 | 3 | 24 | 8.9 | 1.99 | 1.58 | 0.41 | 1.56 | . |
| 807 | 1 | 1 | 4 | 11 | 3 | 25 | 8.3 | 2.25 | 4.60 | 2.26 | 1.32 | . |
| 808 | 1 | 1 | 4 | 11 | 3 | 26 | 8.7 | 2.06 | 3.76 | 0.71 | 1.24 | . |
| 809 | 1 | 1 | 4 | 11 | 3 | 27 | 10.4 | 2.73 | 3.15 | 0.46 | 1.07 | . |
| 810 | 1 | 1 | 4 | 11 | 3 | 28 | 7.8 | 2.18 | 3.39 | 0.26 | 0.92 | . |
| 811 | 1 | 1 | 4 | 11 | 3 | 29 | 8.7 | 2.41 | 4.36 | 0.57 | 1.35 | . |
| 812 | 1 | 1 | 4 | 11 | 3 | 30 | 8.5 | 2.42 | 4.48 | 0.60 | 1.14 | . |
| 813 | 1 | 1 | 4 | 11 | 3 | 31 | 9.4 | 2.44 | 4.12 | 0.77 | 2.21 | . |
| 814 | 1 | 1 | 4 | 11 | 3 | 32 | 9.4 | 2.54 | 3.39 | 0.79 | 1.52 | . |
| 815 | 1 | 1 | 4 | 11 | 3 | 33 | 8.7 | 2.35 | 3.15 | 0.49 | 1.09 | . |
| 816 | 1 | 1 | 4 | 11 | 3 | 34 | 7.0 | 1.99 | 2.79 | 0.19 | 1.11 | . |
| 817 | 1 | 1 | 4 | 11 | 3 | 35 | 8.6 | 2.48 | 3.15 | 0.36 | 1.41 | . |
| 818 | 1 | 1 | 4 | 11 | 3 | 36 | 8.6 | 2.46 | 1.94 | 0.69 | 1.57 | . |
| 819 | 1 | 1 | 4 | 11 | 3 | 37 | 10.3 | 2.68 | 2.54 | 0.52 | 2.32 | . |
| 820 | 1 | 1 | 4 | 11 | 3 | 38 | 9.1 | 2.37 | 3.15 | 0.50 | 0.99 | . |
| 821 | 1 | 1 | 4 | 11 | 3 | 39 | 10.2 | 2.55 | 2.42 | 0.48 | 1.63 | . |
| 822 | 1 | 1 | 4 | 11 | 3 | 40 | 8.7 | 2.24 | 3.27 | 0.40 | 2.21 | . |
| 823 | 1 | 1 | 4 | 11 | 3 | 41 | 9.5 | 2.30 | 3.03 | 0.41 | 1.60 | . |
| 824 | 1 | 1 | 4 | 11 | 3 | 42 | 9.9 | 2.48 | 2.91 | 0.71 | 1.47 | . |
| 825 | 1 | 1 | 4 | 11 | 3 | 43 | 10.3 | 2.69 | 3.51 | 0.60 | 1.85 | . |
| 826 | 1 | 1 | 4 | 11 | 3 | 44 | 8.8 | 2.37 | 3.15 | 0.61 | 1.49 | . |
| 827 | 1 | 1 | 4 | 11 | 3 | 45 | 8.8 | 2.50 | 2.42 | 0.47 | 2.00 | . |
| 828 | 1 | 1 | 4 | 11 | 3 | 46 | 7.5 | 2.30 | 3.51 | 0.25 | 1.39 | . |
| 829 | 1 | 2 | 2 | 5 | 1 | 1 | 11.5 | 2.08 | 7.92 | 1.94 | 0.65 | 0.014 |
| 830 | 1 | 2 | 2 | 5 | 1 | 2 | 11.2 | 1.82 | 8.05 | 1.39 | 0.33 | 0.021 |
| 831 | 1 | 2 | 2 | 5 | 1 | 3 | 11.4 | 1.83 | 7.92 | 0.77 | 0.84 | 0.029 |
| 832 | 1 | 2 | 2 | 5 | 1 | 4 | 11.0 | 2.17 | 6.67 | 0.99 | 0.81 | 0.021 |
| 833 | 1 | 2 | 2 | 5 | 1 | 5 | 10.3 | 2.42 | 7.30 | 0.76 | 0.87 | 0.014 |
| 834 | 1 | 2 | 2 | 5 | 1 | 6 | 11.2 | 2.42 | 7.67 | 0.76 | 0.88 | 0.032 |
| 835 | 1 | 2 | 2 | 5 | 1 | 7 | 12.5 | 1.88 | 6.92 | 1.06 | 0.62 | 0.021 |
| 836 | 1 | 2 | 2 | 5 | 1 | 8 | 11.7 | 2.12 | 6.29 | 1.00 | 0.57 | 0.021 |
| 837 | 1 | 2 | 2 | 5 | 1 | 9 | 11.4 | 2.23 | 7.55 | 1.08 | 0.80 | 0.018 |
| 838 | 1 | 2 | 2 | 5 | 1 | 10 | 11.6 | 2.03 | 6.29 | 0.83 | 0.76 | 0.014 |
| 839 | 1 | 2 | 2 | 5 | 1 | 11 | 11.3 | 1.72 | 6.42 | 0.50 | 0.73 | 0.011 |
| 840 | 1 | 2 | 2 | 5 | 1 | 12 | 10.7 | 1.83 | 7.17 | 0.66 | 0.62 | 0.043 |
| 841 | 1 | 2 | 2 | 5 | 1 | 13 | 12.3 | 2.03 | 6.79 | 0.64 | 1.02 | 0.029 |
| 842 | 1 | 2 | 2 | 5 | 1 | 14 | 11.5 | 2.23 | 6.92 | 0.75 | 0.75 | 0.029 |
| 843 | 1 | 2 | 2 | 5 | 1 | 15 | 10.7 | 2.07 | 9.06 | 1.05 | 0.59 | 0.057 |
| 844 | 1 | 2 | 2 | 5 | 2 | 1 | 7.8 | 2.02 | 8.30 | 0.48 | 2.03 | 0.011 |
| 845 | 1 | 2 | 2 | 5 | 2 | 2 | 9.1 | 1.96 | 7.17 | 0.68 | 1.83 | 0.029 |
| 846 | 1 | 2 | 2 | 5 | 2 | 3 | 9.5 | 2.21 | 8.30 | 0.74 | 0.91 | 0.054 |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 847 | 1 | 2 | 2 | 5 | 2 | 4 | 7.2 | 2.31 | 7.17 | 0.60 | 1.26 | 0.057 |
| 848 | 1 | 2 | 2 | 5 | 2 | 5 | 7.9 | 2.82 | 9.06 | 0.89 | 1.21 | 0.011 |
| 849 | 1 | 2 | 2 | 5 | 2 | 6 | 8.4 | 2.03 | 9.81 | 1.38 | 2.03 | 0.021 |
| 850 | 1 | 2 | 2 | 5 | 2 | 7 | 8.3 | 2.19 | 7.92 | 0.50 | 1.28 | 0.021 |
| 851 | 1 | 2 | 2 | 5 | 2 | 8 | 10.1 | 2.06 | 7.17 | 0.78 | 1.20 | 0.050 |
| 852 | 1 | 2 | 2 | 5 | 2 | 9 | 9.0 | 3.01 | 6.79 | 0.79 | 1.68 | 0.014 |
| 853 | 1 | 2 | 2 | 5 | 2 | 10 | 9.7 | 2.65 | 7.80 | 0.83 | 1.44 | 0.018 |
| 854 | 1 | 2 | 2 | 5 | 2 | 11 | 9.3 | 2.33 | 7.92 | 0.60 | 1.68 | 0.018 |
| 855 | 1 | 2 | 2 | 5 | 2 | 12 | 8.7 | 2.97 | 8.18 | 1.28 | 1.33 | 0.021 |
| 856 | 1 | 2 | 2 | 5 | 2 | 13 | 8.7 | 2.72 | 6.54 | 0.77 | 1.58 | 0.039 |
| 857 | 1 | 2 | 2 | 5 | 2 | 14 | 9.5 | 2.69 | 8.68 | 1.18 | 1.13 | 0.025 |
| 858 | 1 | 2 | 2 | 5 | 2 | 15 | 7.2 | 2.26 | 4.40 | 0.87 | 1.48 | 0.057 |
| 859 | 1 | 2 | 2 | 5 | 3 | 1 | 9.5 | 2.07 | 8.05 | 0.54 | 0.98 | 0.018 |
| 860 | 1 | 2 | 2 | 5 | 3 | 2 | 9.8 | 2.27 | 7.17 | 0.64 | 0.80 | 0.018 |
| 861 | 1 | 2 | 2 | 5 | 3 | 3 | 9.9 | 2.27 | 7.92 | 0.17 | 0.81 | 0.021 |
| 862 | 1 | 2 | 2 | 5 | 3 | 4 | 9.8 | 2.61 | 8.05 | 0.54 | 1.12 | 0.014 |
| 863 | 1 | 2 | 2 | 5 | 3 | 5 | 9.5 | 2.37 | 8.68 | 0.58 | 1.17 | 0.061 |
| 864 | 1 | 2 | 2 | 5 | 3 | 6 | 10.2 | 2.47 | 8.05 | 0.78 | 0.92 | 0.018 |
| 865 | 1 | 2 | 2 | 5 | 3 | 7 | 9.7 | 2.17 | 8.55 | 0.74 | 0.67 | 0.021 |
| 866 | 1 | 2 | 2 | 5 | 3 | 8 | 9.8 | 2.37 | 8.68 | 0.89 | 0.94 | 0.021 |
| 867 | 1 | 2 | 2 | 5 | 3 | 9 | 9.7 | 2.18 | 7.80 | 0.51 | 1.20 | 0.032 |
| 868 | 1 | 2 | 2 | 5 | 3 | 10 | 10.4 | 2.18 | 8.55 | 0.60 | 0.77 | 0.018 |
| 869 | 1 | 2 | 2 | 5 | 3 | 11 | 9.6 | 2.30 | 8.05 | 0.41 | 0.54 | 0.018 |
| 870 | 1 | 2 | 2 | 5 | 3 | 12 | 9.7 | 1.96 | 8.68 | 0.61 | 0.78 | 0.021 |
| 871 | 1 | 2 | 2 | 5 | 3 | 13 | 9.4 | 2.10 | 8.43 | 0.62 | 0.94 | 0.021 |
| 872 | 1 | 2 | 2 | 5 | 3 | 14 | 10.0 | 2.42 | 6.79 | 0.68 | 1.25 | 0.021 |
| 873 | 1 | 2 | 2 | 5 | 3 | 15 | 9.9 | 2.13 | 8.18 | 0.95 | 1.02 | 0.014 |
| 874 | 1 | 2 | 3 | 5 | 1 | 1 | 10.3 | 2.25 | 7.87 | 1.18 | 1.04 | 0.061 |
| 875 | 1 | 2 | 3 | 5 | 1 | 2 | 10.7 | 2.28 | 8.11 | 0.93 | 1.45 | 0.014 |
| 876 | 1 | 2 | 3 | 5 | 1 | 3 | 10.8 | 2.04 | 8.24 | 1.12 | 0.75 | 0.018 |
| 877 | 1 | 2 | 3 | 5 | 1 | 4 | 10.9 | 2.15 | 7.13 | 1.34 | 0.50 | 0.050 |
| 878 | 1 | 2 | 3 | 5 | 1 | 5 | 9.8 | 2.34 | 7.13 | 1.16 | 1.16 | 0.018 |
| 879 | 1 | 2 | 3 | 5 | 1 | 6 | 10.6 | 2.32 | 7.75 | 1.11 | 1.36 | 0.018 |
| 880 | 1 | 2 | 3 | 5 | 1 | 7 | 11.5 | 2.08 | 8.24 | 1.14 | 1.12 | 0.029 |
| 881 | 1 | 2 | 3 | 5 | 1 | 8 | 10.6 | 2.14 | 7.87 | 1.24 | 0.91 | 0.018 |
| 882 | 1 | 2 | 3 | 5 | 1 | 9 | 10.6 | 2.90 | 8.61 | 1.20 | 2.12 | 0.054 |
| 883 | 1 | 2 | 3 | 5 | 1 | 10 | 10.2 | 2.38 | 9.34 | 1.12 | 1.22 | 0.054 |
| 884 | 1 | 2 | 3 | 5 | 1 | 11 | 11.1 | 2.51 | 7.99 | 3.48 | 0.66 | 0.071 |
| 885 | 1 | 2 | 3 | 5 | 1 | 12 | 9.9 | 2.48 | 7.25 | 1.39 | 1.15 | 0.046 |
| 886 | 1 | 2 | 3 | 5 | 2 | 1 | 10.4 | 2.51 | 8.85 | 1.07 | 0.89 | 0.031 |
| 887 | 1 | 2 | 3 | 5 | 2 | 2 | 10.0 | 2.12 | 7.50 | 0.66 | 0.52 | 0.031 |
| 888 | 1 | 2 | 3 | 5 | 2 | 3 | 10.5 | 2.38 | 8.61 | 0.87 | 0.92 | 0.032 |
| 889 | 1 | 2 | 3 | 5 | 2 | 4 | 10.4 | 2.15 | 8.85 | 0.98 | 1.16 | 0.033 |
| 890 | 1 | 2 | 3 | 5 | 2 | 5 | 10.0 | 2.41 | 8.11 | 1.00 | 0.97 | 0.029 |
| 891 | 1 | 2 | 3 | 5 | 2 | 6 | 10.1 | 2.10 | 8.61 | 0.67 | 0.50 | 0.038 |
| 892 | 1 | 2 | 3 | 5 | 2 | 7 | 10.2 | 1.85 | 7.50 | 1.55 | 1.59 | 0.032 |
| 893 | 1 | 2 | 3 | 5 | 2 | 8 | 9.7 | 2.53 | 7.87 | 1.26 | 1.50 | 0.036 |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 894 | 1 | 2 | 3 | 5 | 2 | 9 | 10.0 | 2.37 | 7.99 | 0.89 | 0.36 | 0.031 |
| 895 | 1 | 2 | 3 | 5 | 2 | 10 | 9.8 | 2.34 | 8.85 | 0.77 | 0.03 | 0.031 |
| 896 | 1 | 2 | 3 | 5 | 2 | 11 | 10.0 | 2.37 | 9.22 | 0.92 | 0.17 | 0.032 |
| 897 | 1 | 2 | 3 | 5 | 2 | 12 | 9.2 | 2.60 | 7.62 | 1.03 | 0.60 | 0.042 |
| 898 | 1 | 2 | 3 | 5 | 2 | 13 | 9.5 | 1.42 | 6.27 | 0.77 | 0.00 | 0.046 |
| 899 | 1 | 2 | 3 | 5 | 2 | 14 | 10.8 | 2.74 | 6.39 | 0.82 | 0.51 | 0.031 |
| 900 | 1 | 2 | 3 | 5 | 3 | 1 | 9.6 | 2.26 | 9.22 | 1.38 | 0.07 | 0.029 |
| 901 | 1 | 2 | 3 | 5 | 3 | 2 | 9.4 | 2.50 | 8.85 | 1.90 | 0.24 | 0.043 |
| 902 | 1 | 2 | 3 | 5 | 3 | 3 | 10.0 | 2.25 | 8.36 | 1.21 | 0.07 | 0.031 |
| 903 | 1 | 2 | 3 | 5 | 3 | 4 | 10.6 | 2.11 | 7.01 | 1.26 | 0.50 | 0.028 |
| 904 | 1 | 2 | 3 | 5 | 3 | 5 | 10.5 | 2.26 | 8.21 | 1.32 | 1.01 | 0.032 |
| 905 | 1 | 2 | 3 | 5 | 3 | 6 | 11.2 | 2.08 | 9.71 | 1.31 | 0.42 | 0.031 |
| 906 | 1 | 2 | 3 | 5 | 3 | 7 | 9.6 | 2.39 | 8.48 | 1.17 | 0.14 | 0.035 |
| 907 | 1 | 2 | 3 | 5 | 3 | 8 | 9.4 | 2.18 | 8.33 | 1.01 | 0.27 | 0.046 |
| 908 | 1 | 2 | 3 | 5 | 3 | 9 | 9.8 | 2.37 | 8.73 | 1.26 | 0.17 | 0.036 |
| 909 | 1 | 2 | 3 | 5 | 3 | 10 | 10.5 | 2.47 | 9.59 | 1.12 | 0.50 | 0.035 |
| 910 | 1 | 2 | 3 | 5 | 3 | 11 | 10.0 | 2.28 | 8.11 | 1.17 | 0.70 | 0.033 |
| 911 | 1 | 2 | 3 | 5 | 3 | 12 | 10.2 | 2.42 | 8.73 | 1.16 | 1.27 | 0.031 |
| 912 | 1 | 2 | 3 | 5 | 3 | 13 | 10.1 | 2.29 | 7.25 | 1.20 | 0.46 | 0.045 |
| 913 | 1 | 2 | 3 | 5 | 3 | 14 | 10.2 | 2.38 | 9.34 | 1.15 | 0.99 | 0.032 |
| 914 | 1 | 2 | 4 | 5 | 1 | 1 | 7.1 | 2.59 | 2.50 | 0.69 | 0.98 | 0.032 |
| 915 | 1 | 2 | 4 | 5 | 1 | 2 | 7.6 | 2.52 | 2.13 | 0.65 | 0.53 | 0.026 |
| 916 | 1 | 2 | 4 | 5 | 1 | 3 | 8.3 | 2.45 | 3.50 | 1.37 | 0.94 | 0.042 |
| 917 | 1 | 2 | 4 | 5 | 1 | 4 | 8.5 | 2.80 | 3.00 | 1.27 | 0.84 | 0.032 |
| 918 | 1 | 2 | 4 | 5 | 1 | 5 | 7.5 | 2.78 | 2.25 | 1.35 | 0.89 | 0.038 |
| 919 | 1 | 2 | 4 | 5 | 1 | 6 | 7.8 | 2.61 | 3.50 | 2.77 | 1.03 | 0.039 |
| 920 | 1 | 2 | 4 | 5 | 1 | 7 | 8.3 | 2.31 | 3.38 | 0.90 | 1.26 | 0.026 |
| 921 | 1 | 2 | 4 | 5 | 1 | 8 | 7.6 | 2.68 | 2.50 | 0.83 | 0.85 | 0.028 |
| 922 | 1 | 2 | 4 | 5 | 1 | 9 | 10.0 | 2.98 | 2.75 | 0.87 | 0.75 | 0.032 |
| 923 | 1 | 2 | 4 | 5 | 1 | 10 | 8.3 | 2.56 | 4.00 | 2.15 | 1.04 | 0.033 |
| 924 | 1 | 2 | 4 | 5 | 1 | 11 | 8.2 | 2.25 | 3.25 | 0.73 | 1.06 | 0.035 |
| 925 | 1 | 2 | 4 | 5 | 1 | 12 | 8.2 | 2.97 | 3.13 | 1.16 | 0.85 | 0.035 |
| 926 | 1 | 2 | 4 | 5 | 1 | 13 | 7.9 | 2.69 | 2.38 | 0.57 | 1.17 | 0.038 |
| 927 | 1 | 2 | 4 | 5 | 1 | 14 | 8.7 | 2.86 | 3.75 | 0.74 | 1.06 | 0.039 |
| 928 | 1 | 2 | 4 | 5 | 1 | 15 | 8.2 | 2.61 | 3.50 | 1.16 | 0.79 | 0.038 |
| 929 | 1 | 2 | 4 | 5 | 2 | 1 | 9.1 | 2.46 | 5.67 | 0.87 | 0.65 | 0.023 |
| 930 | 1 | 2 | 4 | 5 | 2 | 2 | 10.0 | 2.22 | 6.87 | 1.29 | 0.50 | 0.020 |
| 931 | 1 | 2 | 4 | 5 | 2 | 3 | 8.9 | 2.08 | 6.63 | 0.82 | 0.74 | 0.023 |
| 932 | 1 | 2 | 4 | 5 | 2 | 4 | 8.4 | 2.09 | 7.23 | 0.85 | 0.76 | 0.033 |
| 933 | 1 | 2 | 4 | 5 | 2 | 5 | 10.8 | 2.46 | 5.18 | 1.32 | 0.37 | 0.027 |
| 934 | 1 | 2 | 4 | 5 | 2 | 6 | 10.1 | 2.39 | 6.27 | 0.92 | 1.10 | 0.030 |
| 935 | 1 | 2 | 4 | 5 | 2 | 7 | 10.0 | 2.68 | 9.16 | 6.95 | 4.50 | 0.077 |
| 936 | 1 | 2 | 4 | 5 | 2 | 8 | 11.8 | 2.33 | 6.75 | 4.35 | 2.00 | 0.030 |
| 937 | 1 | 2 | 4 | 5 | 2 | 9 | 12.7 | 2.39 | 6.87 | 5.49 | 3.00 | 0.027 |
| 938 | 1 | 2 | 4 | 5 | 2 | 10 | 12.0 | 2.54 | 5.18 | 3.37 | 3.60 | 0.027 |
| 939 | 1 | 2 | 4 | 5 | 2 | 11 | 9.7 | 2.37 | 7.11 | 4.58 | 5.20 | 0.037 |
| 940 | 1 | 2 | 4 | 5 | 2 | 12 | 9.1 | 2.59 | 6.99 | 3.55 | 3.80 | 0.030 |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 941 | 1 | 2 | 4 | 5 | 2 | 13 | 11.40 | 2.78 | 9.16 | 6.77 | 2.20 | 0.0230 |
| 942 | 1 | 2 | 4 | 5 | 2 | 14 | 11.20 | 2.47 | 7.60 | 5.18 | 2.80 | 0.0270 |
| 943 | 1 | 2 | 4 | 5 | 2 | 15 | 9.80 | 2.35 | 7.35 | 3.35 | 4.50 | 0.0370 |
| 944 | 1 | 2 | 4 | 5 | 3 | 1 | 10.90 | 2.48 | 7.84 | 3.84 | 3.70 | 0.0270 |
| 945 | 1 | 2 | 4 | 5 | 3 | 2 | 9.70 | 2.21 | 9.16 | 7.42 | 1.90 | 0.0370 |
| 946 | 1 | 2 | 4 | 5 | 3 | 3 | 10.60 | 2.13 | 8.32 | 5.26 | 2.90 | 0.0330 |
| 947 | 1 | 2 | 4 | 5 | 3 | 4 | 9.80 | 2.08 | 8.56 | 3.71 | 4.80 | 0.0500 |
| 948 | 1 | 2 | 4 | 5 | 3 | 5 | 10.50 | 2.44 | 8.44 | 4.69 | 4.60 | 0.0270 |
| 949 | 1 | 2 | 4 | 5 | 3 | 6 | 10.30 | 2.36 | 9.52 | 4.75 | 3.60 | 0.0400 |
| 950 | 1 | 2 | 4 | 5 | 3 | 7 | 10.20 | 2.45 | 7.48 | 3.60 | 2.50 | 0.0500 |
| 951 | 1 | 2 | 4 | 5 | 3 | 8 | 10.60 | 2.23 | 8.92 | 5.03 | 3.60 | 0.0370 |
| 952 | 1 | 2 | 4 | 5 | 3 | 9 | 10.10 | 2.44 | 9.89 | 0.48 | 3.40 | 0.0330 |
| 953 | 1 | 2 | 4 | 5 | 3 | 10 | 11.30 | 2.03 | 8.20 | 5.58 | 2.50 | 0.0300 |
| 954 | 1 | 2 | 4 | 5 | 3 | 11 | 10.40 | 2.09 | 8.08 | 4.31 | 4.30 | 0.0330 |
| 955 | 1 | 2 | 4 | 5 | 3 | 12 | 11.70 | 2.25 | 7.35 | 3.16 | 4.10 | 0.0430 |
| 956 | 1 | 2 | 4 | 5 | 3 | 13 | 10.50 | 2.47 | 9.28 | 5.23 | 5.50 | 0.0830 |
| 957 | 1 | 2 | 4 | 5 | 3 | 14 | 9.60 | 1.97 | 7.23 | 3.47 | 5.10 | 0.0370 |
| 958 | 1 | 2 | 4 | 5 | 3 | 15 | 10.40 | 2.12 | 9.40 | 4.28 | 3.42 | 0.0400 |
| 959 | 1 | 3 | 2 | 11 | 1 | 1 | 9.30 | 2.43 | 1.91 | 0.88 | 0.16 | 0.0354 |
| 960 | 1 | 3 | 2 | 11 | 1 | 2 | 9.24 | 1.71 | 2.03 | 0.66 | 0.62 | 0.0250 |
| 961 | 1 | 3 | 2 | 11 | 1 | 3 | 9.62 | 1.88 | 2.99 | 0.74 | 1.02 | 0.0396 |
| 962 | 1 | 3 | 2 | 11 | 1 | 4 | 9.78 | 1.86 | 3.82 | 1.06 | 1.18 | 0.0375 |
| 963 | 1 | 3 | 2 | 11 | 1 | 5 | 9.38 | 2.00 | 2.03 | 0.62 | 1.17 | 0.0396 |
| 964 | 1 | 3 | 2 | 11 | 1 | 6 | 9.77 | 2.67 | 6.81 | 1.21 | 1.13 | 0.0208 |
| 965 | 1 | 3 | 2 | 11 | 1 | 7 | 8.81 | 2.06 | 2.63 | 0.95 | 0.95 | 0.0458 |
| 966 | 1 | 3 | 2 | 11 | 2 | 1 | 9.71 | 2.12 | 5.37 | 0.84 | 1.58 | 0.0292 |
| 967 | 1 | 3 | 2 | 11 | 2 | 2 | 9.07 | 2.16 | 3.22 | 1.27 | 1.01 | 0.0250 |
| 968 | 1 | 3 | 2 | 11 | 2 | 3 | 9.05 | 2.26 | 3.10 | 0.90 | 1.13 | 0.0438 |
| 969 | 1 | 3 | 2 | 11 | 2 | 4 | 9.36 | 2.17 | 2.75 | 0.66 | 0.82 | 0.0417 |
| 970 | 1 | 3 | 2 | 11 | 2 | 5 | 9.02 | 2.10 | 4.06 | 0.86 | 0.98 | 0.0292 |
| 971 | 1 | 3 | 2 | 11 | 2 | 6 | 9.58 | 1.91 | 5.02 | 0.65 | 0.88 | 0.0354 |
| 972 | 1 | 3 | 2 | 11 | 3 | 1 | 9.78 | 2.48 | 2.87 | 1.22 | 1.68 | 0.0333 |
| 973 | 1 | 3 | 2 | 11 | 3 | 2 | 8.85 | 1.90 | 2.99 | 0.66 | 0.99 | 0.0354 |
| 974 | 1 | 3 | 2 | 11 | 3 | 3 | 9.18 | 2.31 | 5.49 | 0.53 | 0.98 | 0.0417 |
| 975 | 1 | 3 | 2 | 11 | 3 | 4 | 9.05 | 3.23 | 1.55 | 1.51 | 1.75 | 0.0188 |
| 976 | 1 | 3 | 2 | 11 | 3 | 5 | 8.98 | 1.98 | 3.22 | 1.16 | 1.28 | 0.0250 |
| 977 | 1 | 3 | 2 | 11 | 3 | 6 | 9.53 | 1.88 | 4.66 | 0.91 | 1.05 | 0.0208 |
| 978 | 1 | 3 | 3 | 11 | 1 | 1 | 8.82 | 1.90 | 5.13 | 0.99 | 0.94 | 0.0208 |
| 979 | 1 | 3 | 3 | 11 | 1 | 2 | 8.38 | 1.73 | 3.58 | 0.67 | 1.26 | 0.0167 |
| 980 | 1 | 3 | 3 | 11 | 1 | 3 | 8.67 | 1.95 | 3.34 | 0.86 | 1.24 | 0.0208 |
| 981 | 1 | 3 | 3 | 11 | 1 | 4 | 8.72 | 1.51 | 4.66 | 0.89 | 0.87 | 0.0271 |
| 982 | 1 | 3 | 3 | 11 | 1 | 5 | 8.65 | 2.13 | 3.94 | 1.16 | 1.33 | 0.0271 |
| 983 | 1 | 3 | 3 | 11 | 1 | 6 | 9.59 | 2.10 | 4.78 | 1.13 | 1.17 | 0.0333 |
| 984 | 1 | 3 | 3 | 11 | 1 | 7 | 9.37 | 2.19 | 5.49 | 0.72 | 1.36 | 0.0167 |
| 985 | 1 | 3 | 3 | 11 | 2 | 1 | 8.02 | 1.66 | 3.94 | 0.59 | 1.69 | 0.0229 |
| 986 | 1 | 3 | 3 | 11 | 2 | 2 | 8.09 | 1.93 | 2.99 | 1.02 | 1.22 | 0.0146 |
| 987 | 1 | 3 | 3 | 11 | 2 | 3 | 8.27 | 1.78 | 3.10 | 1.41 | 1.49 | 0.0542 |

| OBS | SAM | ANL | YR | MTH | TR | OBS | CA | MG | P | ZN | CU | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 988 | 1 | 3 | 3 | 11 | 2 | 4 | 7.99 | 1.73 | 5.02 | 0.84 | 1.57 | 0.0229 |
| 989 | 1 | 3 | 3 | 11 | 2 | 5 | 7.80 | 1.76 | 3.70 | 0.83 | 1.06 | 0.0146 |
| 990 | 1 | 3 | 3 | 11 | 2 | 6 | 8.29 | 2.02 | 4.54 | 1.17 | 1.38 | 0.0458 |
| 991 | 1 | 3 | 3 | 11 | 2 | 7 | 8.87 | 1.75 | 3.70 | 0.82 | 1.11 | 0.0188 |
| 992 | 1 | 3 | 3 | 11 | 3 | 1 | 8.08 | 1.85 | 4.06 | 0.49 | 1.24 | 0.0479 |
| 993 | 1 | 3 | 3 | 11 | 3 | 2 | 9.03 | 2.19 | 5.61 | 1.25 | 1.07 | 0.0500 |
| 994 | 1 | 3 | 3 | 11 | 3 | 3 | 8.16 | 1.74 | 3.58 | 0.65 | 1.14 | 0.0271 |
| 995 | 1 | 3 | 3 | 11 | 3 | 4 | 8.69 | 2.11 | 3.22 | 0.90 | 1.17 | 0.0250 |
| 996 | 1 | 3 | 3 | 11 | 3 | 5 | 8.80 | 1.99 | 3.10 | 0.89 | 1.28 | 0.0250 |
| 997 | 1 | 3 | 3 | 11 | 3 | 6 | 8.99 | 1.56 | 3.34 | 0.74 | 1.36 | 0.0229 |
| 998 | 1 | 3 | 3 | 11 | 3 | 7 | 8.40 | 1.63 | 3.82 | 0.90 | 1.33 | 0.0146 |
| 999 | 1 | 3 | 4 | 11 | 1 | 1 | 9.64 | 2.55 | 5.97 | 0.86 | 1.36 | 0.0229 |
| 1000 | 1 | 3 | 4 | 11 | 1 | 2 | 8.24 | 2.16 | 4.42 | 0.87 | 1.38 | 0.0083 |
| 1001 | 1 | 3 | 4 | 11 | 1 | 3 | 8.79 | 2.57 | 5.73 | 1.01 | 0.86 | 0.0208 |
| 1002 | 1 | 3 | 4 | 11 | 1 | 4 | 8.26 | 2.33 | 4.42 | 1.46 | 1.30 | 0.0188 |
| 1003 | 1 | 3 | 4 | 11 | 1 | 5 | 5.82 | 1.39 | 2.75 | 0.54 | 0.71 | 0.0250 |
| 1004 | 1 | 3 | 4 | 11 | 1 | 6 | 5.35 | 1.09 | 2.75 | 0.55 | 1.00 | 0.0104 |
| 1005 | 1 | 3 | 4 | 11 | 1 | 7 | 9.01 | 2.18 | 3.34 | 0.68 | 1.02 | 0.0313 |
| 1006 | 1 | 3 | 4 | 11 | 2 | 1 | 8.82 | 2.08 | 5.85 | 0.92 | 1.13 | 0.0250 |
| 1007 | 1 | 3 | 4 | 11 | 2 | 2 | 7.94 | 1.94 | 4.06 | 0.62 | 0.54 | 0.0250 |
| 1008 | 1 | 3 | 4 | 11 | 2 | 3 | 8.66 | 2.18 | 3.34 | 0.62 | 1.04 | 0.0167 |
| 1009 | 1 | 3 | 4 | 11 | 2 | 4 | 7.96 | 1.97 | 4.90 | 1.08 | 0.76 | 0.0146 |
| 1010 | 1 | 3 | 4 | 11 | 2 | 5 | 8.48 | 1.83 | 6.45 | 1.15 | 1.05 | 0.0146 |
| 1011 | 1 | 3 | 4 | 11 | 2 | 6 | 9.22 | 2.26 | 3.82 | 0.71 | 1.52 | 0.1604 |
| 1012 | 1 | 3 | 4 | 11 | 2 | 7 | 8.05 | 2.02 | 4.18 | 0.87 | 1.01 | 0.0167 |
| 1013 | 1 | 3 | 4 | 11 | 3 | 1 | 9.61 | 2.00 | 5.37 | 0.85 | 1.46 | 0.0188 |
| 1014 | 1 | 3 | 4 | 11 | 3 | 2 | 7.56 | 1.75 | 5.37 | 0.28 | 1.29 | 0.0271 |
| 1015 | 1 | 3 | 4 | 11 | 3 | 3 | 8.83 | 1.58 | 3.58 | 0.16 | 1.26 | 0.0313 |
| 1016 | 1 | 3 | 4 | 11 | 3 | 4 | 9.10 | 1.54 | 4.06 | 0.49 | 1.44 | 0.0229 |
| 1017 | 1 | 3 | 4 | 11 | 3 | 5 | 7.88 | 2.05 | 3.58 | 0.87 | 1.41 | 0.0313 |
| 1018 | 1 | 3 | 4 | 11 | 3 | 6 | 8.34 | 1.41 | 3.58 | 0.66 | 1.04 | 0.0313 |
| 1019 | 1 | 3 | 4 | 11 | 3 | 7 | 9.34 | 1.66 | 3.34 | 0.78 | 1.60 | 0.0458 |

# LIVER DATA CODES

OBS = Observation number (1-61).

SAM = Sample type (2= liver).

ANL = Animal type (3= open cow).

YR = Year (2-4).

MTH = Month (11= November).

TR = Treatment (1=LP, 2=MP,3=HP).

OB = Sample observation (1-6,7).

P = Phosphorus, ppm dry matter.

CO = Cobalt, ppm dry matter.

CU = Copper, ppm dry matter.

FE = Iron, ppm dry matter.

MN = Manganese, ppm dry matter.

MO = Molybdenum, ppm dry matter.

SE = Selenium, ppm dry matter.

ZN = Zinc, ppm dry matter.

LIVER DATA

| OBS | SAM | ANL | YR | MTH | TR | OB | P | FE | MN | CU | CO | ZN | MO | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 2 | 11 | 1 | 1 | 0.73 | 332 | 7.72 | 390 | 0.656 | 64.8 | 7.1 | 0.698 |
| 2 | 2 | 3 | 2 | 11 | 1 | 2 | 0.69 | 314 | 7.47 | 329 | 0.406 | 129.4 | 14.6 | 0.410 |
| 3 | 2 | 3 | 2 | 11 | 1 | 3 | 0.71 | 422 | 8.07 | 280 | 0.714 | 154.0 | 11.4 | . |
| 4 | 2 | 3 | 2 | 11 | 1 | 4 | 0.71 | 356 | 7.76 | 333 | 0.592 | 116.0 | 11.0 | . |
| 5 | 2 | 3 | 2 | 11 | 1 | 5 | 0.76 | 227 | 6.53 | 230 | 0.423 | 156.8 | 18.5 | . |
| 6 | 2 | 3 | 2 | 11 | 1 | 6 | 0.74 | 280 | 6.36 | 337 | 0.966 | 161.5 | 7.0 | . |
| 7 | 2 | 3 | 2 | 11 | 1 | 7 | 0.74 | 335 | 9.05 | 293 | 0.655 | 130.9 | 29.3 | 0.685 |
| 8 | 2 | 3 | 2 | 11 | 2 | 1 | 0.85 | 276 | 6.90 | 261 | 1.119 | 59.8 | 10.0 | 0.575 |
| 9 | 2 | 3 | 2 | 11 | 2 | 2 | 0.78 | 301 | 7.53 | 221 | 0.668 | 43.7 | 23.5 | 0.427 |
| 10 | 2 | 3 | 2 | 11 | 2 | 3 | 0.76 | 213 | 8.97 | 227 | 0.831 | 59.0 | 28.1 | . |
| 11 | 2 | 3 | 2 | 11 | 2 | 4 | 0.82 | 116 | 9.47 | 276 | 0.818 | 65.9 | 26.9 | 0.858 |
| 12 | 2 | 3 | 2 | 11 | 2 | 5 | 0.81 | 334 | 6.34 | 289 | 0.542 | 191.5 | 6.8 | . |
| 13 | 2 | 3 | 2 | 11 | 2 | 6 | 0.77 | 169 | 8.46 | 283 | 0.672 | 94.3 | 9.9 | . |
| 14 | 2 | 3 | 2 | 11 | 3 | 1 | 0.72 | 276 | 6.91 | 232 | 0.656 | 79.4 | 11.4 | . |
| 15 | 2 | 3 | 2 | 11 | 3 | 2 | 0.86 | 296 | 12.60 | 203 | 0.833 | 107.4 | 26.2 | 0.650 |
| 16 | 2 | 3 | 2 | 11 | 3 | 3 | 0.73 | 253 | 8.16 | 400 | 0.620 | 98.3 | 8.0 | 0.456 |
| 17 | 2 | 3 | 2 | 11 | 3 | 4 | 0.83 | 244 | 6.49 | 244 | 0.525 | 112.6 | 5.6 | 0.304 |
| 18 | 2 | 3 | 2 | 11 | 3 | 5 | 0.73 | 412 | 7.46 | 171 | 0.596 | 114.0 | 27.0 | . |
| 19 | 2 | 3 | 2 | 11 | 3 | 6 | 0.78 | 296 | 8.32 | 250 | 0.646 | 102.0 | 15.6 | . |
| 20 | 2 | 3 | 3 | 11 | 1 | 1 | 0.75 | 327 | 6.68 | 230 | 0.668 | 111.4 | 30.4 | . |
| 21 | 2 | 3 | 3 | 11 | 1 | 2 | 0.69 | 548 | 6.32 | 190 | 0.618 | 118.7 | 47.1 | . |
| 22 | 2 | 3 | 3 | 11 | 1 | 3 | 0.71 | 332 | 5.70 | 199 | 0.684 | 135.8 | 16.0 | . |
| 23 | 2 | 3 | 3 | 11 | 1 | 4 | 0.76 | 334 | 6.32 | 190 | 0.839 | 159.7 | 37.0 | 0.482 |
| 24 | 2 | 3 | 3 | 11 | 1 | 5 | 0.60 | 328 | 6.86 | 198 | 0.564 | 106.8 | 45.2 | 0.506 |
| 25 | 2 | 3 | 3 | 11 | 1 | 6 | 0.68 | 456 | 7.46 | 240 | 0.738 | 165.0 | 52.8 | . |
| 26 | 2 | 3 | 3 | 11 | 1 | 7 | 0.69 | 380 | 7.01 | 310 | 0.841 | 152.2 | 64.5 | 0.438 |
| 27 | 2 | 3 | 3 | 11 | 2 | 1 | 0.62 | 358 | 5.47 | 334 | 0.644 | 166.5 | 8.1 | . |
| 28 | 2 | 3 | 3 | 11 | 2 | 2 | 0.69 | 373 | 5.08 | 364 | 0.703 | 127.0 | 46.6 | . |
| 29 | 2 | 3 | 3 | 11 | 2 | 3 | 0.76 | 174 | 6.00 | 144 | 0.576 | 90.5 | 14.9 | 0.386 |
| 30 | 2 | 3 | 3 | 11 | 2 | 4 | 0.71 | 375 | 7.08 | 191 | 0.836 | 85.0 | 7.8 | 0.520 |
| 31 | 2 | 3 | 3 | 11 | 2 | 5 | 0.60 | 470 | 4.40 | 205 | 0.712 | 120.3 | 21.1 | . |
| 32 | 2 | 3 | 3 | 11 | 2 | 6 | 0.78 | 194 | 8.85 | 160 | 0.451 | 117.9 | 16.8 | 0.288 |
| 33 | 2 | 3 | 3 | 11 | 2 | 7 | 0.64 | 444 | 1.56 | 78 | 0.537 | 112.1 | 11.3 | . |
| 34 | 2 | 3 | 3 | 11 | 3 | 1 | 0.55 | 483 | 4.69 | 134 | 0.422 | 101.9 | 6.6 | . |
| 35 | 2 | 3 | 3 | 11 | 3 | 2 | 0.79 | 348 | 8.09 | 101 | 0.736 | 102.8 | 10.1 | . |
| 36 | 2 | 3 | 3 | 11 | 3 | 3 | 0.70 | 39 | 7.77 | 39 | 0.610 | 51.1 | 21.8 | . |
| 37 | 2 | 3 | 3 | 11 | 3 | 4 | 0.73 | 249 | 10.25 | 337 | 0.864 | 63.0 | 40.6 | 0.622 |
| 38 | 2 | 3 | 3 | 11 | 3 | 5 | 0.72 | 361 | 8.34 | 454 | 1.001 | 190.0 | 39.9 | . |
| 39 | 2 | 3 | 3 | 11 | 3 | 6 | 0.66 | 405 | 8.10 | 170 | 0.980 | 108.5 | 15.5 | 0.411 |
| 40 | 2 | 3 | 3 | 11 | 3 | 7 | 0.38 | 1045 | 1.71 | 69 | 0.797 | 70.3 | 57.6 | 0.380 |
| 41 | 2 | 3 | 4 | 11 | 1 | 1 | 0.81 | 332 | 10.23 | 345 | 0.844 | 106.1 | 48.7 | 0.457 |
| 42 | 2 | 3 | 4 | 11 | 1 | 2 | 0.79 | 267 | 8.10 | 73 | 1.045 | 263.4 | 51.5 | . |
| 43 | 2 | 3 | 4 | 11 | 1 | 3 | 0.81 | 376 | 9.89 | 326 | 1.029 | 42.5 | 36.2 | . |
| 44 | 2 | 3 | 4 | 11 | 1 | 4 | 0.78 | 309 | 8.88 | 209 | 0.789 | 124.0 | 36.1 | . |
| 45 | 2 | 3 | 4 | 11 | 1 | 5 | 0.74 | 133 | 7.95 | 212 | 0.517 | 82.6 | 20.5 | 0.666 |
| 46 | 2 | 3 | 4 | 11 | 1 | 6 | 0.83 | 381 | 8.61 | 105 | 0.689 | 154.4 | 45.8 | 0.388 |

| OBS | SAM | ANL | YR | MTH | TR | OB | P | FE | MN | CU | CO | ZN | MO | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 47 | 2 | 3 | 4 | 11 | 1 | 7 | 0.70 | 362 | 8.46 | 193 | 0.611 | 97.3 | 13.8 | 0.387 |
| 48 | 2 | 3 | 4 | 11 | 2 | 1 | 0.72 | 316 | 6.82 | 211 | 0.682 | 222.4 | 12.4 | 0.385 |
| 49 | 2 | 3 | 4 | 11 | 2 | 2 | 0.75 | 246 | 8.76 | 285 | 0.559 | 123.8 | 35.5 | 0.370 |
| 50 | 2 | 3 | 4 | 11 | 2 | 3 | 0.76 | 227 | 8.84 | 167 | 0.312 | 110.8 | 7.0 | . |
| 51 | 2 | 3 | 4 | 11 | 2 | 4 | 0.87 | 274 | 8.98 | 103 | 0.490 | 130.3 | 11.3 | . |
| 52 | 2 | 3 | 4 | 11 | 2 | 5 | 0.80 | 186 | 8.86 | 235 | 0.558 | 90.8 | 36.0 | 0.386 |
| 53 | 2 | 3 | 4 | 11 | 2 | 6 | 0.78 | 323 | 7.60 | 143 | 0.599 | 59.4 | 37.5 | . |
| 54 | 2 | 3 | 4 | 11 | 2 | 7 | 0.78 | 283 | 8.54 | 184 | 0.762 | 139.3 | 45.0 | . |
| 55 | 2 | 3 | 4 | 11 | 3 | 1 | 0.85 | 241 | 6.81 | 120 | 0.723 | 157.2 | 36.9 | 0.645 |
| 56 | 2 | 3 | 4 | 11 | 3 | 2 | 0.79 | 304 | 8.28 | 228 | 0.801 | 84.9 | 50.9 | . |
| 57 | 2 | 3 | 4 | 11 | 3 | 3 | 0.82 | 336 | 5.17 | 220 | 1.512 | 257.1 | 93.5 | . |
| 58 | 2 | 3 | 4 | 11 | 3 | 4 | 0.80 | 482 | 7.28 | 510 | 0.768 | 170.9 | 15.3 | . |
| 59 | 2 | 3 | 4 | 11 | 3 | 5 | 0.79 | 250 | 8.16 | 250 | 0.604 | 153.9 | 15.9 | 0.413 |
| 60 | 2 | 3 | 4 | 11 | 3 | 6 | 0.81 | 243 | 7.75 | 183 | 0.825 | 304.9 | 39.5 | 0.444 |
| 61 | 2 | 3 | 4 | 11 | 3 | 7 | 0.78 | 237 | 7.56 | 177 | 0.496 | 94.7 | 8.9 | . |

BONE DATA CODES

OBS = Observation number (1-61).

SAM = Sample type (3= bone).

ANL = Animal type (3= open cow).

YR = Year (2-4).

MTH = Month (11= November).

TR = Treatment (1=LP, 2=MP,3=HP).

OB = Sample observation (1-6,7).

CA = Calcium, % dry, fat-free basis.

MG = Magnesium, % dry, fat-free basis.

ASH = Bone ash, % dry, fat free basis.

SG = Specific gravity, $g/cm^3$, fresh basis.

BONE DATA

| OBS | SAM | ANL | YR | MTH | TR | OB | CA | MG | P | ASH | SG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 2 | 11 | 1 | 1 | 17.2 | 0.127 | 17.65 | 66.82 | 1.483 |
| 2 | 3 | 3 | 2 | 11 | 1 | 2 | 18.3 | 0.119 | 17.74 | 66.83 | 1.377 |
| 3 | 3 | 3 | 2 | 11 | 1 | 3 | 27.5 | 0.248 | 17.20 | 67.53 | 1.487 |
| 4 | 3 | 3 | 2 | 11 | 1 | 4 | 24.9 | 0.250 | 17.70 | 66.93 | 1.267 |
| 5 | 3 | 3 | 2 | 11 | 1 | 5 | 19.6 | 0.168 | 17.77 | 64.82 | 1.522 |
| 6 | 3 | 3 | 2 | 11 | 1 | 6 | 23.6 | 0.272 | 16.49 | 64.65 | 1.416 |
| 7 | 3 | 3 | 2 | 11 | 1 | 7 | 23.9 | 0.191 | 18.52 | 67.34 | 1.231 |
| 8 | 3 | 3 | 2 | 11 | 2 | 1 | 30.7 | 0.326 | 17.49 | 67.43 | 1.453 |
| 9 | 3 | 3 | 2 | 11 | 2 | 2 | 34.3 | 0.401 | 17.62 | 67.48 | 1.427 |
| 10 | 3 | 3 | 2 | 11 | 2 | 3 | 29.6 | 0.363 | 18.04 | 67.33 | 1.463 |
| 11 | 3 | 3 | 2 | 11 | 2 | 4 | 26.6 | 0.279 | 14.42 | 66.38 | 1.467 |
| 12 | 3 | 3 | 2 | 11 | 2 | 5 | 17.2 | 0.137 | 16.51 | 67.44 | 1.452 |
| 13 | 3 | 3 | 2 | 11 | 2 | 6 | 27.7 | 0.308 | 16.23 | 65.86 | 1.363 |
| 14 | 3 | 3 | 2 | 11 | 3 | 1 | 21.9 | 0.210 | 17.42 | 66.60 | 1.403 |
| 15 | 3 | 3 | 2 | 11 | 3 | 2 | 29.6 | 0.380 | 17.84 | 66.83 | 1.539 |
| 16 | 3 | 3 | 2 | 11 | 3 | 3 | 19.6 | 0.105 | 17.89 | 67.70 | 1.329 |
| 17 | 3 | 3 | 2 | 11 | 3 | 4 | 30.3 | 0.324 | 17.95 | 67.83 | 1.507 |
| 18 | 3 | 3 | 2 | 11 | 3 | 5 | 18.1 | 0.156 | 17.85 | 66.52 | 1.503 |
| 19 | 3 | 3 | 2 | 11 | 3 | 6 | 15.8 | 0.091 | 17.29 | 65.95 | 1.474 |
| 20 | 3 | 3 | 3 | 11 | 1 | 1 | 29.2 | 0.320 | 17.27 | 66.14 | 1.320 |
| 21 | 3 | 3 | 3 | 11 | 1 | 2 | 26.3 | 0.307 | 17.34 | 66.85 | 1.507 |
| 22 | 3 | 3 | 3 | 11 | 1 | 3 | 23.5 | 0.303 | 17.43 | 66.77 | 1.562 |
| 23 | 3 | 3 | 3 | 11 | 1 | 4 | 22.5 | 0.222 | 17.88 | 67.21 | 1.562 |
| 24 | 3 | 3 | 3 | 11 | 1 | 5 | 24.9 | 0.296 | 17.23 | 65.34 | 1.586 |
| 25 | 3 | 3 | 3 | 11 | 1 | 6 | 22.9 | 0.325 | 16.25 | 63.46 | 1.667 |
| 26 | 3 | 3 | 3 | 11 | 1 | 7 | 18.0 | 0.232 | 16.84 | 64.21 | 1.473 |
| 27 | 3 | 3 | 3 | 11 | 2 | 1 | 13.5 | 0.143 | 17.82 | 66.36 | 1.538 |
| 28 | 3 | 3 | 3 | 11 | 2 | 2 | 11.8 | 0.127 | 17.21 | 65.03 | 1.452 |
| 29 | 3 | 3 | 3 | 11 | 2 | 3 | 12.5 | 0.090 | 16.85 | 65.67 | 1.557 |
| 30 | 3 | 3 | 3 | 11 | 2 | 4 | 30.8 | 0.352 | 17.65 | 66.44 | 1.646 |
| 31 | 3 | 3 | 3 | 11 | 2 | 5 | 30.5 | 0.381 | 17.36 | 66.01 | 1.465 |
| 32 | 3 | 3 | 3 | 11 | 2 | 6 | 14.3 | 0.143 | 15.94 | 65.96 | 1.555 |
| 33 | 3 | 3 | 3 | 11 | 2 | 7 | 30.1 | 0.336 | 17.11 | 66.85 | 1.473 |
| 34 | 3 | 3 | 3 | 11 | 3 | 1 | 7.8 | 0.054 | 17.30 | 65.36 | 1.449 |
| 35 | 3 | 3 | 3 | 11 | 3 | 2 | 30.9 | 0.422 | 17.98 | 66.90 | 1.515 |
| 36 | 3 | 3 | 3 | 11 | 3 | 3 | 20.9 | 0.251 | 16.92 | 66.88 | 1.473 |
| 37 | 3 | 3 | 3 | 11 | 3 | 4 | 10.5 | 0.112 | 17.92 | 66.83 | 1.544 |
| 38 | 3 | 3 | 3 | 11 | 3 | 5 | 15.8 | 0.122 | 18.25 | 66.74 | 1.615 |
| 39 | 3 | 3 | 3 | 11 | 3 | 6 | 24.4 | 0.250 | 15.75 | 67.52 | 1.572 |
| 40 | 3 | 3 | 3 | 11 | 3 | 7 | 28.5 | 0.319 | 15.68 | 65.48 | 1.646 |
| 41 | 3 | 3 | 4 | 11 | 1 | 1 | 28.0 | 0.358 | 17.18 | 66.86 | 1.453 |
| 42 | 3 | 3 | 4 | 11 | 1 | 2 | 29.3 | 0.344 | 17.85 | 67.31 | 1.551 |
| 43 | 3 | 3 | 4 | 11 | 1 | 3 | 30.8 | 0.395 | 17.47 | 66.07 | 1.515 |
| 44 | 3 | 3 | 4 | 11 | 1 | 4 | 31.0 | 0.410 | 16.91 | 65.23 | 1.660 |
| 45 | 3 | 3 | 4 | 11 | 1 | 5 | 31.7 | 0.316 | 17.97 | 67.17 | 1.575 |
| 46 | 3 | 3 | 4 | 11 | 1 | 6 | 10.2 | 0.081 | 16.12 | 65.17 | 1.568 |

| OBS | SAM | ANL | YR | MTH | TR | OB | CA | MG | P | ASH | SG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 47 | 3 | 3 | 4 | 11 | 1 | 7 | 32.4 | 0.349 | 17.20 | 65.22 | 1.468 |
| 48 | 3 | 3 | 4 | 11 | 2 | 1 | 29.3 | 0.386 | 18.18 | 67.51 | 1.423 |
| 49 | 3 | 3 | 4 | 11 | 2 | 2 | 28.6 | 0.020 | 17.21 | 66.63 | 1.648 |
| 50 | 3 | 3 | 4 | 11 | 2 | 3 | 28.1 | 0.369 | 17.49 | 65.77 | 1.605 |
| 51 | 3 | 3 | 4 | 11 | 2 | 4 | 28.3 | 0.364 | 17.42 | 66.88 | 1.506 |
| 52 | 3 | 3 | 4 | 11 | 2 | 5 | 29.0 | 0.337 | 18.04 | 67.31 | 1.602 |
| 53 | 3 | 3 | 4 | 11 | 2 | 6 | 28.2 | 0.337 | 17.47 | 66.55 | 1.498 |
| 54 | 3 | 3 | 4 | 11 | 2 | 7 | 29.9 | 0.330 | 16.99 | 66.11 | 1.550 |
| 55 | 3 | 3 | 4 | 11 | 3 | 1 | 28.7 | 0.350 | 18.04 | 67.14 | 1.472 |
| 56 | 3 | 3 | 4 | 11 | 3 | 2 | 28.7 | 0.320 | 17.46 | 66.97 | 1.536 |
| 57 | 3 | 3 | 4 | 11 | 3 | 3 | 18.5 | 0.213 | 16.11 | 66.09 | 1.551 |
| 58 | 3 | 3 | 4 | 11 | 3 | 4 | 30.3 | 0.322 | 17.45 | 66.31 | 1.423 |
| 59 | 3 | 3 | 4 | 11 | 3 | 5 | 32.3 | 0.327 | 16.15 | 66.32 | 1.513 |
| 60 | 3 | 3 | 4 | 11 | 3 | 6 | 27.1 | 0.293 | 16.66 | 65.70 | 1.517 |
| 61 | 3 | 3 | 4 | 11 | 3 | 7 | 28.0 | 0.310 | 17.31 | 66.37 | 1.496 |

# HAIR DATA CODES

OBS = Observation number (1-61).

SAM = Sample type (4= HAIR).

ANL = Animal type (3= open cow).

YR = Year (2-4).

MTH = Month (11= November).

TR = Treatment (1=LP, 2=MP, 3=HP).

OB = Sample observation (1-6,7).

SE = Selenium, ppm.

HAIR DATA

| OBS | SAM | ANL | YR | MTH | TR | OB | SE |
|---|---|---|---|---|---|---|---|
| 1 | 4 | 3 | 2 | 11 | 1 | 1 | 0.973 |
| 2 | 4 | 3 | 2 | 11 | 1 | 2 | 0.633 |
| 3 | 4 | 3 | 2 | 11 | 1 | 3 | 0.989 |
| 4 | 4 | 3 | 2 | 11 | 1 | 4 | 0.831 |
| 5 | 4 | 3 | 2 | 11 | 1 | 5 | 0.632 |
| 6 | 4 | 3 | 2 | 11 | 1 | 6 | 0.856 |
| 7 | 4 | 3 | 2 | 11 | 1 | 7 | 0.990 |
| 8 | 4 | 3 | 2 | 11 | 2 | 1 | 0.791 |
| 9 | 4 | 3 | 2 | 11 | 2 | 2 | 0.770 |
| 10 | 4 | 3 | 2 | 11 | 2 | 3 | 0.980 |
| 11 | 4 | 3 | 2 | 11 | 2 | 4 | 0.880 |
| 12 | 4 | 3 | 2 | 11 | 2 | 5 | 0.647 |
| 13 | 4 | 3 | 2 | 11 | 2 | 6 | 0.905 |
| 14 | 4 | 3 | 2 | 11 | 3 | 1 | 0.635 |
| 15 | 4 | 3 | 2 | 11 | 3 | 2 | 0.623 |
| 16 | 4 | 3 | 2 | 11 | 3 | 3 | 0.487 |
| 17 | 4 | 3 | 2 | 11 | 3 | 4 | 0.416 |
| 18 | 4 | 3 | 2 | 11 | 3 | 5 | 0.514 |
| 19 | 4 | 3 | 2 | 11 | 3 | 6 | 0.550 |
| 20 | 4 | 3 | 3 | 11 | 1 | 1 | 0.621 |
| 21 | 4 | 3 | 3 | 11 | 1 | 2 | 0.632 |
| 22 | 4 | 3 | 3 | 11 | 1 | 3 | 0.611 |
| 23 | 4 | 3 | 3 | 11 | 1 | 4 | 0.648 |
| 24 | 4 | 3 | 3 | 11 | 1 | 5 | 0.586 |
| 25 | 4 | 3 | 3 | 11 | 1 | 6 | 0.670 |
| 26 | 4 | 3 | 3 | 11 | 1 | 7 | 0.548 |
| 27 | 4 | 3 | 3 | 11 | 2 | 1 | 0.661 |
| 28 | 4 | 3 | 3 | 11 | 2 | 2 | 0.623 |
| 29 | 4 | 3 | 3 | 11 | 2 | 3 | 0.730 |
| 30 | 4 | 3 | 3 | 11 | 2 | 4 | 0.719 |
| 31 | 4 | 3 | 3 | 11 | 2 | 5 | 0.547 |
| 32 | 4 | 3 | 3 | 11 | 2 | 6 | 0.548 |
| 33 | 4 | 3 | 3 | 11 | 2 | 7 | 0.668 |
| 34 | 4 | 3 | 3 | 11 | 3 | 1 | 0.390 |
| 35 | 4 | 3 | 3 | 11 | 3 | 2 | 0.546 |
| 36 | 4 | 3 | 3 | 11 | 3 | 3 | 0.450 |
| 37 | 4 | 3 | 3 | 11 | 3 | 4 | 0.485 |
| 38 | 4 | 3 | 3 | 11 | 3 | 5 | 0.509 |
| 39 | 4 | 3 | 3 | 11 | 3 | 6 | 0.426 |
| 40 | 4 | 3 | 3 | 11 | 3 | 7 | 0.559 |
| 41 | 4 | 3 | 4 | 11 | 1 | 1 | 0.534 |
| 42 | 4 | 3 | 4 | 11 | 1 | 2 | 0.586 |
| 43 | 4 | 3 | 4 | 11 | 1 | 3 | 0.735 |
| 44 | 4 | 3 | 4 | 11 | 1 | 4 | 0.633 |
| 45 | 4 | 3 | 4 | 11 | 1 | 5 | 0.685 |
| 46 | 4 | 3 | 4 | 11 | 1 | 6 | 0.533 |

| OBS | SAM | ANL | YR | MTH | TR | OB | SE |
|---|---|---|---|---|---|---|---|
| 47 | 4 | 3 | 4 | 11 | 1 | 7 | 0.624 |
| 48 | 4 | 3 | 4 | 11 | 2 | 1 | 0.570 |
| 49 | 4 | 3 | 4 | 11 | 2 | 2 | 0.459 |
| 50 | 4 | 3 | 4 | 11 | 2 | 3 | 0.472 |
| 51 | 4 | 3 | 4 | 11 | 2 | 4 | 0.471 |
| 52 | 4 | 3 | 4 | 11 | 2 | 5 | 0.585 |
| 53 | 4 | 3 | 4 | 11 | 2 | 6 | 0.535 |
| 54 | 4 | 3 | 4 | 11 | 2 | 7 | 0.561 |
| 55 | 4 | 3 | 4 | 11 | 3 | 1 | 0.597 |
| 56 | 4 | 3 | 4 | 11 | 3 | 2 | 0.433 |
| 57 | 4 | 3 | 4 | 11 | 3 | 3 | 0.559 |
| 58 | 4 | 3 | 4 | 11 | 3 | 4 | 0.484 |
| 59 | 4 | 3 | 4 | 11 | 3 | 5 | 0.686 |
| 60 | 4 | 3 | 4 | 11 | 3 | 6 | 0.645 |
| 61 | 4 | 3 | 4 | 11 | 3 | 7 | 0.435 |

# SOIL DATA CODES

OBS = Observatiion number (1-546).

SAM = Sample type.

YR = Year (2-3).

MTH = Month (1-12).

TR = Treatment (1-3)

OB = Sample observation (1-21).

Macrominerals (Dry matter basis)

AL = Aluminum, ppm

CA = Calcium, ppm.

K = Potassium, ppm.

MG = Magnesium, ppm.

NA = Sodium, ppm.

P = Phosphorus, ppm.

OM = Soil organic matter, %.

PH = Soil pH.

Microminerals (Dry matter basis)

FE = Iron, ppm.

CU = Copper, ppm.

MN = Manganese, ppm.

ZN = Zinc, ppm.

SOIL DATA

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6 | 2 | 5 | 1 | 1 | 670 | 89 | 13 | 8.4 | 5.2 | 4.4 | 0.56 | 0.52 | 0.04 | 16 | 2.4 | 5.2 |
| 2 | 6 | 2 | 5 | 1 | 2 | 592 | 62 | 11 | 7.6 | 5.2 | 4.4 | 0.28 | 0.24 | 0.08 | 16 | 1.9 | 5.2 |
| 3 | 6 | 2 | 5 | 1 | 3 | 890 | 76 | 12 | 11.2 | 7.6 | 9.2 | 0.44 | 0.56 | 0.04 | 28 | 4.5 | 5.0 |
| 4 | 6 | 2 | 5 | 1 | 4 | 582 | 38 | 7 | 10.0 | 3.2 | 18.0 | 0.16 | 0.24 | 0.04 | 22 | 2.8 | 5.1 |
| 5 | 6 | 2 | 5 | 1 | 5 | 901 | 37 | 10 | 11.6 | 5.2 | 12.8 | 0.40 | 0.32 | 0.00 | 34 | 3.1 | 5.3 |
| 6 | 6 | 2 | 5 | 1 | 6 | 814 | 66 | 20 | 16.8 | 9.2 | 6.8 | 0.96 | 0.84 | 0.08 | 21 | 4.2 | 4.9 |
| 7 | 6 | 2 | 5 | 2 | 7 | 725 | 18 | 7 | 8.4 | 3.6 | 3.2 | 0.48 | 0.16 | 0.04 | 16 | 2.2 | 5.8 |
| 8 | 6 | 2 | 5 | 2 | 8 | 542 | 16 | 7 | 8.8 | 2.8 | 2.8 | 0.36 | 0.16 | 0.08 | 15 | 1.4 | 5.6 |
| 9 | 6 | 2 | 5 | 2 | 9 | 972 | 40 | 12 | 10.8 | 6.8 | 6.0 | 0.52 | 0.36 | 0.12 | 21 | 3.5 | 5.3 |
| 10 | 6 | 2 | 5 | 2 | 10 | 518 | 13 | 6 | 6.4 | 2.8 | 2.8 | 0.40 | 0.16 | 0.08 | 10 | 3.0 | 5.8 |
| 11 | 6 | 2 | 5 | 2 | 11 | 466 | 30 | 11 | 9.6 | 4.4 | 8.0 | 0.32 | 0.32 | 0.08 | 16 | 1.4 | 4.8 |
| 12 | 6 | 2 | 5 | 2 | 12 | 555 | 30 | 9 | 10.4 | 4.0 | 7.2 | 0.32 | 0.36 | 0.08 | 17 | 2.1 | 5.2 |
| 13 | 6 | 2 | 5 | 2 | 13 | 520 | 23 | 9 | 4.0 | 4.8 | 4.0 | 0.80 | 1.80 | 0.08 | 17 | 2.0 | 5.2 |
| 14 | 6 | 2 | 5 | 2 | 14 | 327 | 29 | 15 | 5.6 | 5.6 | 4.0 | 1.40 | 0.80 | 0.12 | 10 | 1.6 | 5.2 |
| 15 | 6 | 2 | 5 | 2 | 15 | 619 | 12 | 4 | 6.8 | 3.2 | 2.4 | 0.76 | 0.16 | 0.08 | 11 | 1.2 | 5.9 |
| 16 | 6 | 2 | 5 | 3 | 16 | 652 | 21 | 12 | 12.8 | 6.4 | 4.0 | 0.84 | 0.48 | 0.16 | 14 | 1.8 | 5.3 |
| 17 | 6 | 2 | 5 | 3 | 17 | 662 | 22 | 8 | 6.4 | 5.6 | 3.6 | 0.88 | 0.40 | 0.08 | 13 | 2.6 | 5.4 |
| 18 | 6 | 2 | 5 | 3 | 18 | 413 | 14 | 6 | 6.4 | 3.2 | 3.2 | 0.56 | 0.32 | 0.24 | 8 | 1.4 | 5.6 |
| 19 | 6 | 2 | 5 | 3 | 19 | 1123 | 44 | 15 | 9.2 | 8.8 | 5.2 | 2.60 | 1.60 | 0.08 | 36 | 3.6 | 5.3 |
| 20 | 6 | 2 | 5 | 3 | 20 | 921 | 61 | 12 | 6.8 | 6.4 | 12.8 | 2.50 | 3.80 | 0.20 | 39 | 2.7 | 5.5 |
| 21 | 6 | 2 | 5 | 3 | 21 | 1625 | 111 | 10 | 6.8 | 10.0 | 3.2 | 3.00 | 1.20 | 0.08 | 31 | 2.7 | 6.5 |
| 22 | 6 | 2 | 11 | 1 | 1 | 589 | 60 | 12 | 68.8 | 6.8 | 12.8 | 1.00 | 0.88 | 0.80 | 196 | 1.9 | 5.3 |
| 23 | 6 | 2 | 11 | 1 | 2 | 893 | 148 | 9 | 62.4 | 4.8 | 4.0 | 0.64 | 0.52 | 0.80 | 30 | 3.0 | 5.7 |
| 24 | 6 | 2 | 11 | 1 | 3 | 382 | 35 | 10 | 56.4 | 3.6 | 6.0 | 0.20 | 0.36 | 0.16 | 19 | 2.5 | 4.9 |
| 25 | 6 | 2 | 11 | 1 | 4 | 528 | 43 | 7 | 57.6 | 3.6 | 14.0 | 0.36 | 0.40 | 0.00 | 76 | 3.7 | 4.8 |
| 26 | 6 | 2 | 11 | 1 | 5 | 543 | 50 | 7 | 58.8 | 3.2 | 5.2 | 0.44 | 0.28 | 1.00 | 29 | 2.7 | 5.0 |
| 27 | 6 | 2 | 11 | 1 | 6 | 669 | 58 | 10 | 62.8 | 4.0 | 6.0 | 0.40 | 0.32 | 0.88 | 35 | 1.7 | 5.3 |
| 28 | 6 | 2 | 11 | 2 | 7 | 576 | 46 | 10 | 8.8 | 7.2 | 2.8 | 1.30 | 0.84 | 0.44 | 12 | 1.7 | 5.7 |
| 29 | 6 | 2 | 11 | 2 | 8 | 1048 | 20 | 9 | 7.6 | 4.8 | 4.0 | 0.80 | 0.32 | 0.20 | 22 | 2.3 | 5.6 |
| 30 | 6 | 2 | 11 | 2 | 9 | 570 | 33 | 18 | 6.4 | 5.2 | 2.4 | 0.96 | 0.28 | 0.32 | 11 | 1.2 | 5.7 |
| 31 | 6 | 2 | 11 | 2 | 10 | 583 | 38 | 10 | 7.2 | 4.4 | 4.4 | 1.10 | 1.20 | 0.28 | 17 | 2.7 | 5.1 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32 | 6 | 2 | 11 | 2 | 11 | 332 | 51 | 16 | 8.4 | 6.4 | 8.4 | 0.56 | 0.56 | 0.84 | 19 | 3.7 | 4.4 |
| 33 | 6 | 2 | 11 | 2 | 12 | 484 | 24 | 11 | 6.4 | 9.6 | 3.6 | 0.68 | 0.48 | 0.24 | 52 | 2.4 | 5.0 |
| 34 | 6 | 2 | 11 | 2 | 13 | 644 | 31 | 23 | 8.4 | 12.8 | 11.2 | 1.40 | 0.76 | 0.20 | 356 | 2.5 | 5.3 |
| 35 | 6 | 2 | 11 | 2 | 14 | 295 | 32 | 19 | 6.4 | 4.8 | 2.8 | 2.40 | 1.20 | 0.48 | 9 | 1.3 | 5.2 |
| 36 | 6 | 2 | 11 | 2 | 15 | 1032 | 88 | 17 | 65.6 | 5.2 | 3.2 | 2.40 | 1.00 | 0.12 | 33 | 2.1 | 5.8 |
| 37 | 6 | 2 | 11 | 3 | 16 | 503 | 49 | 7 | 54.8 | 3.6 | 7.6 | 0.32 | 0.76 | 0.12 | 36 | 2.5 | 5.6 |
| 38 | 6 | 2 | 11 | 3 | 17 | 957 | 84 | 12 | 70.8 | 6.0 | 8.0 | 0.60 | 1.20 | 0.08 | 48 | 3.8 | 6.0 |
| 39 | 6 | 2 | 11 | 3 | 18 | 1025 | 150 | 9 | 59.2 | 6.4 | 3.2 | 1.20 | 0.56 | 0.12 | 27 | 1.9 | 6.8 |
| 40 | 6 | 2 | 11 | 3 | 19 | 1265 | 46 | 10 | 52.8 | 8.8 | 4.8 | 2.90 | 2.60 | 0.12 | 148 | 2.6 | 6.0 |
| 41 | 6 | 2 | 11 | 3 | 20 | 545 | 26 | 7 | 58.4 | 4.0 | 2.8 | 0.76 | 0.72 | 0.12 | 16 | 1.5 | 5.7 |
| 42 | 6 | 2 | 11 | 3 | 21 | 803 | 32 | 11 | 57.2 | 6.0 | 4.0 | 1.10 | 0.92 | 0.04 | 23 | 2.0 | 5.7 |
| 43 | 6 | 3 | 1 | 1 | 1 | 604 | 54 | 19 | 49.6 | 6.0 | 3.6 | 2.84 | 3.60 | 0.80 | 19 | 2.3 | 5.4 |
| 44 | 6 | 3 | 1 | 1 | 2 | 1142 | 120 | 34 | 56.4 | 8.0 | 4.4 | 1.12 | 1.04 | 0.12 | 28 | 4.0 | 5.8 |
| 45 | 6 | 3 | 1 | 1 | 3 | 460 | 66 | 18 | 68.8 | 9.2 | 6.8 | 0.64 | 1.32 | 0.48 | 18 | 2.3 | 5.0 |
| 46 | 6 | 3 | 1 | 1 | 4 | 476 | 32 | 14 | 51.6 | 3.6 | 5.6 | 0.36 | 0.40 | 0.04 | 20 | 2.3 | 5.1 |
| 47 | 6 | 3 | 1 | 1 | 5 | 836 | 93 | 10 | 66.4 | 4.4 | 9.6 | 0.20 | 0.32 | 0.04 | 41 | 2.6 | 5.4 |
| 48 | 6 | 3 | 1 | 1 | 6 | 609 | 56 | 36 | 138.0 | 56.0 | 6.0 | 1.92 | 6.00 | 0.64 | 24 | 3.1 | 4.7 |
| 49 | 6 | 3 | 1 | 2 | 7 | 580 | 10 | 23 | 58.8 | 3.6 | 9.2 | 0.20 | 0.36 | 0.24 | 59 | 1.1 | 5.8 |
| 50 | 6 | 3 | 1 | 2 | 8 | 334 | 14 | 11 | 66.8 | 3.6 | 13.6 | 0.20 | 0.36 | 0.16 | 91 | 1.7 | 5.6 |
| 51 | 6 | 3 | 1 | 2 | 9 | 352 | 17 | 17 | 73.6 | 3.6 | 12.8 | 0.40 | 0.40 | 0.16 | 73 | 1.5 | 5.4 |
| 52 | 6 | 3 | 1 | 2 | 10 | 552 | 58 | 12 | 73.6 | 5.6 | 17.2 | 0.16 | 0.36 | 0.04 | 71 | 3.6 | 4.6 |
| 53 | 6 | 3 | 1 | 2 | 11 | 1117 | 154 | 12 | 61.2 | 5.2 | 4.4 | 0.72 | 0.52 | 0.04 | 33 | 3.6 | 5.2 |
| 54 | 6 | 3 | 1 | 2 | 12 | 471 | 45 | 19 | 58.8 | 5.2 | 4.8 | 0.20 | 0.44 | 0.04 | 16 | 1.9 | 5.3 |
| 55 | 6 | 3 | 1 | 2 | 13 | 1074 | 23 | 15 | 54.0 | 6.8 | 4.0 | 0.88 | 0.52 | 0.36 | 28 | 2.5 | 5.6 |
| 56 | 6 | 3 | 1 | 2 | 14 | 867 | 24 | 12 | 49.6 | 5.6 | 3.2 | 21.00 | 0.68 | 0.36 | 22 | 2.6 | 5.5 |
| 57 | 6 | 3 | 1 | 2 | 15 | 796 | 37 | 15 | 62.4 | 5.2 | 2.4 | 1.56 | 1.00 | 0.44 | 20 | 1.6 | 5.7 |
| 58 | 6 | 3 | 1 | 3 | 16 | 845 | 46 | 18 | 56.4 | 8.4 | 3.6 | 1.96 | 1.20 | 0.12 | 20 | 2.5 | 5.5 |
| 59 | 6 | 3 | 1 | 3 | 17 | 404 | 12 | 16 | 60.0 | 5.2 | 3.6 | 0.76 | 0.64 | 0.16 | 10 | 2.2 | 5.0 |
| 60 | 6 | 3 | 1 | 3 | 18 | 780 | 34 | 16 | 10.0 | 6.0 | 4.0 | 1.84 | 0.96 | 0.56 | 18 | 2.6 | 5.4 |
| 61 | 6 | 3 | 1 | 3 | 19 | 1183 | 20 | 9 | 11.2 | 9.2 | 8.8 | 2.00 | 1.32 | 0.60 | 62 | 2.3 | 6.0 |
| 62 | 6 | 3 | 1 | 3 | 20 | 1004 | 58 | 10 | 8.0 | 4.0 | 3.6 | 1.56 | 1.40 | 0.16 | 40 | 2.8 | 5.7 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 63 | 6 | 3 | 1 | 3 | 21 | 844 | 48 | 14 | 6.0 | 4.8 | 3.6 | 1.72 | 1.08 | 0.80 | 31 | 2.0 | 5.8 |
| 64 | 6 | 3 | 2 | 1 | 1 | 1463 | 130 | 36 | 24.0 | 13.6 | 4.8 | 4.24 | 1.08 | 0.00 | 28 | 6.7 | 5.1 |
| 65 | 6 | 3 | 2 | 1 | 2 | 732 | 176 | 94 | 8.8 | 8.4 | 2.4 | 1.40 | 1.40 | 0.00 | 10 | 2.5 | 5.7 |
| 66 | 6 | 3 | 2 | 1 | 3 | 720 | 98 | 41 | 6.4 | 8.0 | 2.8 | 2.04 | 1.16 | 0.00 | 11 | 2.7 | 5.5 |
| 67 | 6 | 3 | 2 | 1 | 4 | 1466 | 126 | 50 | 12.0 | 19.6 | 5.2 | 4.60 | 1.60 | 0.00 | 21 | 8.4 | 5.3 |
| 68 | 6 | 3 | 2 | 1 | 5 | 1366 | 245 | 28 | 11.6 | 11.2 | 4.0 | 2.92 | 1.64 | 0.00 | 23 | 5.1 | 5.5 |
| 69 | 6 | 3 | 2 | 1 | 6 | 1273 | 154 | 34 | 14.4 | 9.6 | 4.4 | 1.28 | 0.40 | 0.00 | 22 | 13.5 | 4.9 |
| 70 | 6 | 3 | 2 | 2 | 7 | 1522 | 96 | 65 | 8.8 | 10.0 | 3.2 | 2.24 | 0.80 | 0.00 | 54 | 4.8 | 5.6 |
| 71 | 6 | 3 | 2 | 2 | 8 | 2435 | 289 | 31 | 13.2 | 15.2 | 4.8 | 4.56 | 1.48 | 0.12 | 65 | 6.2 | 6.0 |
| 72 | 6 | 3 | 2 | 2 | 9 | 639 | 52 | 59 | 18.8 | 3.6 | 4.8 | 0.48 | 0.36 | 0.20 | 16 | 4.7 | 5.6 |
| 73 | 6 | 3 | 2 | 2 | 10 | 1095 | 141 | 23 | 18.4 | 13.2 | 3.6 | 1.04 | 0.52 | 0.04 | 22 | 4.6 | 5.3 |
| 74 | 6 | 3 | 2 | 2 | 11 | 1260 | 114 | 32 | 22.4 | 16.8 | 4.8 | 0.44 | 0.60 | 0.00 | 29 | 6.1 | 4.9 |
| 75 | 6 | 3 | 2 | 2 | 12 | 1341 | 131 | 24 | 14.4 | 13.6 | 5.2 | 2.56 | 2.12 | 0.16 | 2 | 5.3 | 5.0 |
| 76 | 6 | 3 | 2 | 2 | 13 | 475 | 89 | 30 | 5.6 | 7.6 | 3.2 | 1.24 | 3.00 | 0.08 | 32 | 2.4 | 5.0 |
| 77 | 6 | 3 | 2 | 2 | 14 | 350 | 71 | 29 | 3.6 | 7.6 | 2.8 | 2.76 | 2.52 | 0.16 | 29 | 1.2 | 5.5 |
| 78 | 6 | 3 | 2 | 2 | 15 | 310 | 69 | 22 | 9.6 | 6.4 | 2.0 | 3.12 | 2.72 | 0.16 | 9 | 1.3 | 5.7 |
| 79 | 6 | 3 | 2 | 3 | 16 | 1527 | 79 | 40 | 8.4 | 19.6 | 24.8 | 2.82 | 1.25 | 15.96 | 70 | 3.8 | 5.9 |
| 80 | 6 | 3 | 2 | 3 | 17 | 1288 | 116 | 53 | 6.4 | 16.0 | 2.4 | 9.56 | 4.24 | 0.00 | 18 | 3.5 | 6.1 |
| 81 | 6 | 3 | 2 | 3 | 18 | 980 | 92 | 36 | 7.2 | 10.8 | 2.8 | 5.64 | 1.60 | 0.00 | 10 | 3.7 | 5.6 |
| 82 | 6 | 3 | 2 | 3 | 19 | 2896 | 87 | 23 | 7.2 | 22.4 | 7.2 | 2.92 | 3.32 | 0.16 | 66 | 3.6 | 7.1 |
| 83 | 6 | 3 | 2 | 3 | 20 | 954 | 84 | 18 | 15.6 | 8.4 | 5.2 | 2.64 | 2.64 | 0.08 | 33 | 4.5 | 5.2 |
| 84 | 6 | 3 | 2 | 3 | 21 | 1511 | 145 | 112 | 6.4 | 7.6 | 2.8 | 2.92 | 1.84 | 0.04 | 43 | 3.4 | 6.6 |
| 85 | 6 | 3 | 3 | 1 | 1 | 1010 | 104 | 29 | 11.6 | 9.2 | 5.2 | 1.12 | 1.04 | 0.16 | 174 | 12.2 | 5.4 |
| 86 | 6 | 3 | 3 | 1 | 2 | 998 | 96 | 27 | 9.6 | 6.8 | 7.6 | 0.72 | 0.48 | 0.08 | 33 | 3.8 | 5.3 |
| 87 | 6 | 3 | 3 | 1 | 3 | 740 | 83 | 19 | 6.4 | 9.2 | 4.4 | 1.56 | 2.24 | 0.12 | 26 | 3.0 | 4.9 |
| 88 | 6 | 3 | 3 | 1 | 4 | 658 | 50 | 22 | 12.0 | 5.2 | 8.0 | 0.20 | 0.36 | 0.04 | 21 | 6.4 | 4.7 |
| 89 | 6 | 3 | 3 | 1 | 5 | 1204 | 66 | 14 | 16.0 | 6.4 | 8.4 | 0.52 | 0.24 | 0.04 | 36 | 6.4 | 5.2 |
| 90 | 6 | 3 | 3 | 1 | 6 | 1030 | 87 | 25 | 13.2 | 7.2 | 4.0 | 1.16 | 0.36 | 0.04 | 16 | 7.9 | 5.0 |
| 91 | 6 | 3 | 3 | 2 | 7 | 1396 | 155 | 13 | 11.2 | 8.4 | 6.0 | 0.68 | 0.68 | 0.12 | 29 | 6.0 | 5.7 |
| 92 | 6 | 3 | 3 | 2 | 8 | 816 | 60 | 15 | 8.0 | 5.2 | 9.6 | 0.20 | 0.36 | 0.00 | 24 | 4.3 | 5.3 |
| 93 | 6 | 3 | 3 | 2 | 9 | 857 | 100 | 23 | 7.2 | 7.6 | 3.6 | 1.80 | 0.68 | 0.00 | 14 | 3.2 | 5.6 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 94 | 6 | 3 | 3 | 2 | 10 | 323 | 46 | 43 | 5.2 | 11.2 | 4.8 | 2.92 | 2.00 | 0.12 | 8 | 2.1 | 4.7 |
| 95 | 6 | 3 | 3 | 2 | 11 | 249 | 38 | 43 | 3.6 | 7.2 | 3.2 | 2.12 | 2.20 | 0.08 | 7 | 1.5 | 5.1 |
| 96 | 6 | 3 | 3 | 2 | 12 | 218 | 30 | 28 | 3.6 | 8.8 | 4.8 | 2.20 | 1.88 | 0.12 | 6 | 1.4 | 5.0 |
| 97 | 6 | 3 | 3 | 2 | 13 | 606 | 40 | 20 | 8.8 | 8.4 | 3.2 | 1.84 | 0.64 | 0.04 | 8 | 2.7 | 5.2 |
| 98 | 6 | 3 | 3 | 2 | 14 | 891 | 64 | 25 | 10.8 | 9.2 | 4.4 | 2.52 | 2.36 | 0.24 | 15 | 4.1 | 5.3 |
| 99 | 6 | 3 | 3 | 2 | 15 | 509 | 81 | 20 | 8.8 | 6.4 | 3.2 | 1.32 | 0.60 | 0.04 | 10 | 3.1 | 5.1 |
| 100 | 6 | 3 | 3 | 3 | 16 | 1263 | 115 | 49 | 4.8 | 10.0 | 4.8 | 1.92 | 9.20 | 0.04 | 29 | 7.2 | 5.4 |
| 101 | 6 | 3 | 3 | 3 | 17 | 666 | 58 | 37 | 4.4 | 7.2 | 3.2 | 0.88 | 0.44 | 0.04 | 14 | 2.9 | 5.2 |
| 102 | 6 | 3 | 3 | 3 | 18 | 465 | 39 | 28 | 3.2 | 8.0 | 3.6 | 2.16 | 1.56 | 0.08 | 8 | 2.5 | 5.1 |
| 103 | 6 | 3 | 3 | 3 | 19 | 1114 | 51 | 25 | 6.4 | 12.4 | 5.6 | 2.52 | 3.96 | 0.08 | 25 | 3.5 | 5.1 |
| 104 | 6 | 3 | 3 | 3 | 20 | 745 | 56 | 26 | 5.6 | 8.8 | 3.2 | 2.76 | 1.00 | 0.08 | 14 | 2.0 | 5.2 |
| 105 | 6 | 3 | 3 | 3 | 21 | 713 | 76 | 20 | 7.2 | 8.0 | 2.8 | 2.24 | 1.88 | 0.04 | 10 | 2.2 | 5.4 |
| 106 | 6 | 3 | 4 | 1 | 1 | 102 | 149 | 26 | 6.8 | 10.4 | 3.6 | 2.64 | 2.08 | 0.08 | 22 | 3.7 | 5.1 |
| 107 | 6 | 3 | 4 | 1 | 2 | 567 | 152 | 232 | 9.2 | 7.2 | 3.6 | 5.24 | 3.96 | 0.04 | 13 | 2.4 | 6.2 |
| 108 | 6 | 3 | 4 | 1 | 3 | 755 | 138 | 26 | 4.4 | 9.2 | 3.6 | 5.56 | 4.72 | 0.12 | 15 | 4.1 | 5.0 |
| 109 | 6 | 3 | 4 | 1 | 4 | 887 | 253 | 36 | 9.6 | 13.2 | 3.6 | 2.64 | 2.16 | 0.04 | 15 | 7.6 | 5.2 |
| 110 | 6 | 3 | 4 | 1 | 5 | 1394 | 273 | 52 | 9.2 | 9.6 | 2.8 | 2.16 | 2.56 | 0.04 | 19 | 5.4 | 5.5 |
| 111 | 6 | 3 | 4 | 1 | 6 | 1714 | 357 | 20 | 12.4 | 11.6 | 2.8 | 2.24 | 1.84 | 0.08 | 32 | 4.9 | 6.3 |
| 112 | 6 | 3 | 4 | 2 | 7 | 696 | 101 | 30 | 10.8 | 8.8 | 3.2 | 0.48 | 0.64 | 0.04 | 10 | 5.9 | 5.2 |
| 113 | 6 | 3 | 4 | 2 | 8 | 656 | 112 | 23 | 8.0 | 9.6 | 4.0 | 0.80 | 1.16 | 0.24 | 11 | 4.9 | 5.0 |
| 114 | 6 | 3 | 4 | 2 | 9 | 1614 | 103 | 21 | 19.6 | 9.6 | 8.4 | 0.40 | 0.52 | 0.08 | 30 | 4.7 | 5.7 |
| 115 | 6 | 3 | 4 | 2 | 10 | 1283 | 67 | 26 | 20.0 | 7.6 | 7.2 | 0.20 | 0.40 | 0.08 | 25 | 5.4 | 5.1 |
| 116 | 6 | 3 | 4 | 2 | 11 | 1014 | 62 | 19 | 11.6 | 6.8 | 3.2 | 0.20 | 0.36 | 0.04 | 14 | 4.6 | 5.4 |
| 117 | 6 | 3 | 4 | 2 | 12 | 618 | 95 | 26 | 9.2 | 8.4 | 3.2 | 2.68 | 2.08 | 0.12 | 10 | 3.5 | 5.0 |
| 118 | 6 | 3 | 4 | 2 | 13 | 507 | 78 | 28 | 6.8 | 12.0 | 8.4 | 1.20 | 2.96 | 0.16 | 29 | 5.0 | 4.2 |
| 119 | 6 | 3 | 4 | 2 | 14 | 272 | 61 | 27 | 4.0 | 9.6 | 6.0 | 1.88 | 2.12 | 0.16 | 12 | 2.8 | 4.0 |
| 120 | 6 | 3 | 4 | 2 | 15 | 470 | 81 | 35 | 3.6 | 9.6 | 6.0 | 6.40 | 6.96 | 0.28 | 11 | 3.5 | 4.6 |
| 121 | 6 | 3 | 4 | 3 | 16 | 878 | 105 | 44 | 13.2 | 12.0 | 4.4 | 5.00 | 2.72 | 0.08 | 17 | 4.1 | 5.1 |
| 122 | 6 | 3 | 4 | 3 | 17 | 977 | 98 | 48 | 10.8 | 13.2 | 4.4 | 4.04 | 1.72 | 0.08 | 22 | 4.7 | 5.2 |
| 123 | 6 | 3 | 4 | 3 | 18 | 939 | 88 | 23 | 10.4 | 8.8 | 0.2 | 4.32 | 1.60 | 0.08 | 12 | 3.4 | 5.8 |
| 124 | 6 | 3 | 4 | 3 | 19 | 1348 | 207 | 26 | 18.0 | 15.2 | 50.4 | 10.68 | 38.96 | 0.32 | 50 | 6.4 | 5.6 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 125 | 6 | 3 | 4 | 3 | 20 | 1774 | 129 | 29 | 12.8 | 12.8 | 35.6 | 6.00 | 6.76 | 0.16 | 36 | 4.3 | 6.2 |
| 126 | 6 | 3 | 4 | 3 | 21 | 1914 | 76 | 17 | 13.2 | 12.8 | 4.0 | 6.64 | 3.44 | 0.16 | 120 | 3.8 | 6.0 |
| 127 | 6 | 3 | 5 | 1 | 1 | 1818 | 266 | 33 | 24.8 | 12.0 | 8.4 | 2.96 | 1.56 | 0.08 | 77 | 6.8 | 5.6 |
| 128 | 6 | 3 | 5 | 1 | 2 | 468 | 125 | 52 | 9.6 | 12.0 | 4.4 | 4.88 | 6.52 | 0.20 | 15 | 3.3 | 5.2 |
| 129 | 6 | 3 | 5 | 1 | 3 | 948 | 194 | 28 | 16.0 | 13.6 | 4.8 | 1.48 | 1.96 | 0.00 | 22 | 4.1 | 5.1 |
| 130 | 6 | 3 | 5 | 1 | 4 | 847 | 108 | 37 | 24.0 | 12.4 | 4.4 | 2.96 | 1.00 | 0.00 | 18 | 7.7 | 5.0 |
| 131 | 6 | 3 | 5 | 1 | 5 | 813 | 158 | 34 | 14.8 | 10.8 | 6.0 | 2.00 | 0.72 | 0.00 | 27 | 6.2 | 5.2 |
| 132 | 6 | 3 | 5 | 1 | 6 | 1297 | 254 | 30 | 42.4 | 22.0 | 4.4 | 3.52 | 2.64 | 0.00 | 30 | 10.0 | 5.3 |
| 133 | 6 | 3 | 5 | 2 | 7 | 1541 | 88 | 11 | 25.2 | 10.0 | 9.2 | 0.48 | 0.32 | 0.08 | 68 | 5.0 | 6.0 |
| 134 | 6 | 3 | 5 | 2 | 8 | 928 | 114 | 20 | 12.8 | 10.0 | 3.2 | 3.36 | 0.92 | 0.08 | 18 | 2.9 | 6.1 |
| 135 | 6 | 3 | 5 | 2 | 9 | 1182 | 115 | 21 | 16.8 | 14.4 | 3.6 | 2.16 | 0.80 | 0.08 | 23 | 3.5 | 5.9 |
| 136 | 6 | 3 | 5 | 2 | 10 | 1458 | 114 | 18 | 13.2 | 8.4 | 17.2 | 1.96 | 0.52 | 0.40 | 34 | 4.9 | 5.7 |
| 137 | 6 | 3 | 5 | 2 | 11 | 1326 | 41 | 12 | 15.6 | 8.0 | 3.2 | 0.20 | 0.24 | 0.00 | 24 | 4.8 | 5.6 |
| 138 | 6 | 3 | 5 | 2 | 12 | 526 | 39 | 72 | 20.4 | 8.8 | 6.8 | 0.20 | 0.44 | 0.12 | 21 | 5.3 | 5.0 |
| 139 | 6 | 3 | 5 | 2 | 13 | 330 | 47 | 32 | 9.2 | 7.2 | 2.8 | 3.88 | 2.52 | 0.16 | 9 | 2.1 | 5.4 |
| 140 | 6 | 3 | 5 | 2 | 14 | 493 | 50 | 26 | 9.2 | 6.4 | 2.4 | 1.56 | 1.16 | 0.04 | 9 | 7.2 | 5.3 |
| 141 | 6 | 3 | 5 | 2 | 15 | 553 | 62 | 29 | 8.0 | 9.6 | 4.8 | 1.36 | 1.24 | 0.28 | 17 | 2.8 | 4.8 |
| 142 | 6 | 3 | 5 | 3 | 16 | 532 | 17 | 15 | 10.4 | 6.0 | 3.2 | 0.68 | 0.40 | 0.40 | 13 | 2.2 | 5.4 |
| 143 | 6 | 3 | 5 | 3 | 17 | 517 | 18 | 11 | 8.8 | 5.2 | 3.2 | 1.08 | 0.80 | 0.04 | 12 | 1.8 | 5.5 |
| 144 | 6 | 3 | 5 | 3 | 18 | 474 | 37 | 18 | 6.0 | 6.0 | 2.4 | 1.20 | 0.52 | 0.00 | 10 | 4.3 | 5.5 |
| 145 | 6 | 3 | 5 | 3 | 19 | 864 | 46 | 14 | 7.6 | 6.8 | 2.8 | 1.40 | 0.92 | 0.00 | 20 | 1.3 | 5.3 |
| 146 | 6 | 3 | 5 | 3 | 20 | 553 | 11 | 7 | 8.4 | 2.8 | 2.4 | 0.48 | 0.24 | 0.00 | 13 | 2.2 | 5.8 |
| 147 | 6 | 3 | 5 | 3 | 21 | 587 | 13 | 14 | 13.6 | 6.0 | 17.6 | 0.36 | 0.56 | 0.04 | 49 | 3.0 | 4.9 |
| 148 | 6 | 3 | 6 | 1 | 1 | 143 | 136 | 23 | 14.0 | 8.0 | 6.0 | 1.36 | 1.28 | 0.04 | 104 | 5.4 | 5.6 |
| 149 | 6 | 3 | 6 | 1 | 2 | 926 | 100 | 36 | 12.0 | 9.6 | 3.2 | 1.56 | 1.04 | 0.00 | 40 | 2.9 | 5.5 |
| 150 | 6 | 3 | 6 | 1 | 3 | 1341 | 190 | 162 | 13.2 | 17.2 | 3.9 | 2.16 | 2.52 | 0.08 | 31 | 2.2 | 5.8 |
| 151 | 6 | 3 | 6 | 1 | 4 | 1782 | 150 | 114 | 39.6 | 12.8 | 5.6 | 2.16 | 1.24 | 0.00 | 34 | 5.5 | 5.3 |
| 152 | 6 | 3 | 6 | 1 | 5 | 1156 | 68 | 21 | 10.8 | 7.6 | 4.4 | 1.24 | 0.60 | 0.00 | 20 | 4.5 | 5.4 |
| 153 | 6 | 3 | 6 | 1 | 6 | 928 | 101 | 72 | 18.0 | 13.2 | 5.2 | 1.36 | 1.12 | 0.00 | 23 | 5.8 | 5.1 |
| 154 | 6 | 3 | 6 | 2 | 7 | 1261 | 67 | 30 | 10.0 | 13.6 | 4.0 | 3.16 | 2.48 | 0.08 | 33 | 8.9 | 5.6 |
| 155 | 6 | 3 | 6 | 2 | 8 | 1498 | 67 | 42 | 27.2 | 12.8 | 3.6 | 2.44 | 1.56 | 0.12 | 33 | 4.5 | 6.0 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 156 | 6 | 3 | 6 | 2 | 9 | 2498 | 58 | 19 | 12.0 | 18.0 | 3.2 | 2.24 | 0.80 | 0.12 | 32 | 4.7 | 6.2 |
| 157 | 6 | 3 | 6 | 2 | 10 | 927 | 92 | 19 | 10.0 | 8.8 | 3.2 | 1.76 | 0.56 | 0.04 | 17 | 3.4 | 5.4 |
| 158 | 6 | 3 | 6 | 2 | 11 | 876 | 62 | 19 | 13.2 | 7.6 | 2.8 | 1.12 | 0.52 | 0.08 | 16 | 3.0 | 5.3 |
| 159 | 6 | 3 | 6 | 2 | 12 | 804 | 101 | 26 | 18.0 | 8.4 | 3.6 | 0.44 | 1.24 | 0.08 | 24 | 4.2 | 4.9 |
| 160 | 6 | 3 | 6 | 2 | 13 | 576 | 61 | 89 | 12.4 | 8.8 | 6.4 | 1.00 | 1.32 | 0.08 | 25 | 2.5 | 4.9 |
| 161 | 6 | 3 | 6 | 2 | 14 | 587 | 38 | 62 | 10.0 | 9.2 | 4.8 | 1.44 | 1.32 | 0.08 | 19 | 5.4 | 4.8 |
| 162 | 6 | 3 | 6 | 2 | 15 | 582 | 29 | 21 | 10.0 | 8.4 | 5.6 | 1.16 | 1.00 | 0.08 | 22 | 3.7 | 4.6 |
| 163 | 6 | 3 | 6 | 3 | 16 | 1422 | 16 | 21 | 8.0 | 6.0 | 4.4 | 0.76 | 0.28 | 0.00 | 26 | 3.8 | 5.4 |
| 164 | 6 | 3 | 6 | 3 | 17 | 1000 | 42 | 14 | 7.2 | 6.4 | 7.6 | 1.88 | 2.36 | 0.04 | 19 | 2.0 | 5.9 |
| 165 | 6 | 3 | 6 | 3 | 18 | 887 | 40 | 21 | 10.0 | 8.4 | 8.0 | 0.44 | 0.48 | 0.00 | 37 | 5.1 | 4.8 |
| 166 | 6 | 3 | 6 | 3 | 19 | 858 | 43 | 8 | 3.6 | 4.4 | 2.4 | 1.88 | 1.40 | 0.08 | 25 | 5.3 | 5.8 |
| 167 | 6 | 3 | 6 | 3 | 20 | 1524 | 119 | 19 | 12.0 | 10.8 | 4.4 | 4.12 | 2.56 | 0.16 | 49 | 4.1 | 5.7 |
| 168 | 6 | 3 | 6 | 3 | 21 | 1062 | 96 | 22 | 12.4 | 9.6 | 10.4 | 3.12 | 7.88 | 0.24 | 51 | 3.3 | 5.4 |
| 169 | 6 | 3 | 7 | 1 | 1 | 785 | 56 | 14 | 9.6 | 10.8 | 15.2 | 1.72 | 1.40 | 0.12 | 170 | 1.1 | 5.7 |
| 170 | 6 | 3 | 7 | 1 | 2 | 3359 | 42 | 21 | 7.2 | 6.0 | 14.4 | 0.56 | 0.60 | 0.04 | 176 | 1.6 | 5.4 |
| 171 | 6 | 3 | 7 | 1 | 3 | 553 | 55 | 19 | 7.6 | 6.0 | 2.4 | 1.32 | 0.84 | 0.04 | 44 | 0.4 | 5.7 |
| 172 | 6 | 3 | 7 | 1 | 4 | 562 | 34 | 8 | 11.2 | 4.0 | 6.8 | 0.44 | 0.20 | 0.00 | 19 | 0.9 | 5.4 |
| 173 | 6 | 3 | 7 | 1 | 5 | 542 | 40 | 10 | 14.0 | 4.0 | 8.8 | 0.20 | 0.24 | 0.00 | 35 | 1.8 | 5.0 |
| 174 | 6 | 3 | 7 | 1 | 6 | 808 | 64 | 11 | 11.6 | 4.8 | 4.8 | 0.60 | 0.40 | 0.00 | 23 | 2.0 | 5.7 |
| 175 | 6 | 3 | 7 | 2 | 7 | 724 | 34 | 10 | 8.0 | 5.6 | 0.3 | 1.08 | 0.72 | 0.04 | 15 | 2.0 | 5.6 |
| 176 | 6 | 3 | 7 | 2 | 8 | 443 | 30 | 16 | 7.2 | 6.0 | 4.8 | 0.44 | 0.32 | 0.08 | 32 | 1.6 | 5.1 |
| 177 | 6 | 3 | 7 | 2 | 9 | 830 | 54 | 15 | 7.2 | 10.8 | 5.2 | 1.12 | 0.68 | 0.08 | 40 | 2.2 | 5.3 |
| 178 | 6 | 3 | 7 | 2 | 10 | 430 | 29 | 7 | 9.2 | 4.0 | 6.4 | 0.16 | 0.12 | 0.00 | 22 | 2.4 | 5.1 |
| 179 | 6 | 3 | 7 | 2 | 11 | 523 | 36 | 7 | 7.6 | 4.8 | 8.8 | 0.32 | 0.28 | 0.12 | 28 | 2.0 | 5.4 |
| 180 | 6 | 3 | 7 | 2 | 12 | 499 | 44 | 11 | 8.8 | 5.6 | 5.6 | 0.36 | 0.24 | 0.04 | 19 | 2.5 | 4.9 |
| 181 | 6 | 3 | 7 | 2 | 13 | 507 | 22 | 9 | 8.0 | 5.6 | 3.6 | 1.12 | 1.08 | 0.32 | 12 | 3.7 | 5.2 |
| 182 | 6 | 3 | 7 | 2 | 14 | 559 | 22 | 8 | 8.4 | 4.8 | 3.2 | 0.60 | 0.56 | 0.08 | 13 | 2.2 | 5.3 |
| 183 | 6 | 3 | 7 | 2 | 15 | 337 | 54 | 12 | 18.4 | 7.6 | 12.0 | 0.16 | 0.36 | 0.00 | 21 | 10.3 | 4.4 |
| 184 | 6 | 3 | 7 | 3 | 16 | 714 | 47 | 12 | 6.8 | 5.2 | 2.0 | 1.40 | 0.64 | 0.08 | 14 | 1.4 | 5.5 |
| 185 | 6 | 3 | 7 | 3 | 17 | 364 | 26 | 10 | 5.2 | 4.4 | 3.6 | 1.08 | 0.60 | 0.04 | 6 | 1.3 | 5.4 |
| 186 | 6 | 3 | 7 | 3 | 18 | 370 | 25 | 10 | 4.8 | 4.8 | 3.6 | 1.68 | 1.04 | 0.04 | 6 | 1.2 | 5.5 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 187 | 6 | 3 | 7 | 3 | 19 | 565 | 30 | 7 | 6.0 | 5.2 | 15.6 | 1.36 | 2.68 | 0.16 | 86 | 1.1 | 5.6 |
| 188 | 6 | 3 | 7 | 3 | 20 | 1064 | 40 | 14 | 8.8 | 13.2 | 12.0 | 2.24 | 2.52 | 0.12 | 30 | 1.3 | 5.7 |
| 189 | 6 | 3 | 7 | 3 | 21 | 782 | 28 | 9 | 6.8 | 8.4 | 4.4 | 1.56 | 1.08 | 0.04 | 24 | 1.4 | 6.3 |
| 190 | 6 | 3 | 8 | 1 | 1 | 1411 | 210 | 29 | 16.0 | 10.4 | 6.8 | 1.04 | 0.84 | 0.00 | 46 | 9.1 | 5.3 |
| 191 | 6 | 3 | 8 | 1 | 2 | 1084 | 126 | 26 | 18.8 | 12.0 | 7.6 | 1.28 | 1.80 | 0.04 | 251 | 8.4 | 5.3 |
| 192 | 6 | 3 | 8 | 1 | 3 | 1782 | 174 | 23 | 8.8 | 13.6 | 2.2 | 4.72 | 1.48 | 0.00 | 25 | 2.8 | 6.4 |
| 193 | 6 | 3 | 8 | 1 | 4 | 1008 | 81 | 24 | 10.4 | 9.2 | 4.4 | 1.36 | 0.64 | 0.00 | 20 | 5.4 | 5.0 |
| 194 | 6 | 3 | 8 | 1 | 5 | 856 | 61 | 24 | 14.8 | 8.8 | 6.4 | 0.72 | 0.52 | 0.16 | 24 | 4.8 | 4.8 |
| 195 | 6 | 3 | 8 | 1 | 6 | 1286 | 85 | 35 | 14.8 | 9.6 | 4.4 | 0.84 | 0.80 | 0.00 | 39 | 6.6 | 5.0 |
| 196 | 6 | 3 | 8 | 2 | 7 | 1157 | 98 | 26 | 9.6 | 19.6 | 6.0 | 2.00 | 0.60 | 0.04 | 188 | 5.5 | 6.1 |
| 197 | 6 | 3 | 8 | 2 | 8 | 1746 | 189 | 22 | 9.2 | 20.4 | 9.6 | 3.40 | 0.64 | 0.08 | 470 | 5.3 | 6.3 |
| 198 | 6 | 3 | 8 | 2 | 9 | 2055 | 169 | 22 | 13.2 | 12.8 | 3.6 | 2.08 | 0.52 | 0.04 | 178 | 7.9 | 5.8 |
| 199 | 6 | 3 | 8 | 2 | 10 | 1143 | 78 | 14 | 12.0 | 6.4 | 6.4 | 0.40 | 0.48 | 0.08 | 41 | 4.1 | 8.4 |
| 200 | 6 | 3 | 8 | 2 | 11 | 848 | 51 | 20 | 18.4 | 7.6 | 11.2 | 0.20 | 0.44 | 0.20 | 38 | 3.8 | 5.0 |
| 201 | 6 | 3 | 8 | 2 | 12 | 882 | 114 | 16 | 10.8 | 6.8 | 3.2 | 1.16 | 0.40 | 0.00 | 16 | 3.8 | 5.4 |
| 202 | 6 | 3 | 8 | 2 | 13 | 557 | 40 | 15 | 6.4 | 8.0 | 4.0 | 2.08 | 1.28 | 0.08 | 12 | 1.2 | 5.3 |
| 203 | 6 | 3 | 8 | 2 | 14 | 636 | 74 | 73 | 11.2 | 4.4 | 4.0 | 1.48 | 1.40 | 0.08 | 13 | 1.9 | 5.9 |
| 204 | 6 | 3 | 8 | 2 | 15 | 917 | 56 | 17 | 9.2 | 7.6 | 4.4 | 2.24 | 1.88 | 0.16 | 16 | 2.4 | 5.3 |
| 205 | 6 | 3 | 8 | 3 | 16 | 984 | 84 | 31 | 15.2 | 11.2 | 4.4 | 2.92 | 1.60 | 0.20 | 16 | 2.5 | 5.2 |
| 206 | 6 | 3 | 8 | 3 | 17 | 2300 | 129 | 31 | 17.6 | 15.6 | 2.8 | 4.08 | 1.60 | 0.20 | 38 | 3.1 | 6.3 |
| 207 | 6 | 3 | 8 | 3 | 18 | 680 | 48 | 19 | 9.6 | 5.6 | 5.2 | 2.24 | 0.72 | 0.16 | 9 | 2.0 | 5.6 |
| 208 | 6 | 3 | 8 | 3 | 19 | 1170 | 19 | 22 | 10.4 | 6.8 | 8.4 | 2.40 | 3.08 | 0.28 | 55 | 3.5 | 5.5 |
| 209 | 6 | 3 | 8 | 3 | 20 | 1475 | 28 | 16 | 12.0 | 7.2 | 2.8 | 2.40 | 1.28 | 0.20 | 54 | 3.5 | 6.0 |
| 210 | 6 | 3 | 8 | 3 | 21 | 913 | 17 | 10 | 8.8 | 6.0 | 5.2 | 2.12 | 1.28 | 0.32 | 65 | 2.1 | 5.9 |
| 211 | 6 | 3 | 9 | 1 | 1 | 1972 | 231 | 37 | 23.6 | 13.6 | 8.0 | 2.76 | 1.32 | 0.12 | 294 | 9.1 | 6.0 |
| 212 | 6 | 3 | 9 | 1 | 2 | 541 | 88 | 40 | 67.6 | 12.8 | 4.4 | 1.76 | 1.96 | 0.16 | 18 | 2.7 | 5.3 |
| 213 | 6 | 3 | 9 | 1 | 3 | 679 | 67 | 67 | 16.4 | 30.0 | 7.2 | 6.48 | 9.88 | 0.68 | 207 | 1.9 | 5.7 |
| 214 | 6 | 3 | 9 | 1 | 4 | 1091 | 79 | 25 | 15.6 | 8.0 | 4.4 | 1.52 | 1.24 | 0.08 | 22 | 4.9 | 5.3 |
| 215 | 6 | 3 | 9 | 1 | 5 | 1068 | 80 | 86 | 25.6 | 9.6 | 5.6 | 0.60 | 0.52 | 0.08 | 23 | 5.0 | 5.2 |
| 216 | 6 | 3 | 9 | 1 | 6 | 816 | 87 | 84 | 23.6 | 9.6 | 4.8 | 1.00 | 0.68 | 0.08 | 16 | 3.4 | 5.5 |
| 217 | 6 | 3 | 9 | 2 | 7 | 1619 | 150 | 87 | 28.4 | 26.0 | 3.2 | 2.40 | 0.48 | 0.16 | 95 | 4.0 | 6.6 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 218 | 6 | 3 | 9 | 2 | 8 | 1259 | 108 | 16 | 13.6 | 9.6 | 3.2 | 1.56 | 0.40 | 0.16 | 47 | 3.5 | 5.8 |
| 219 | 6 | 3 | 9 | 2 | 9 | 1650 | 205 | 34 | 18.0 | 12.4 | 3.2 | 2.40 | 0.72 | 0.12 | 35 | 5.7 | 5.8 |
| 220 | 6 | 3 | 9 | 2 | 10 | 1371 | 59 | 16 | 18.8 | 12.0 | 4.4 | 1.96 | 0.52 | 0.16 | 28 | 3.8 | 5.9 |
| 221 | 6 | 3 | 9 | 2 | 11 | 1263 | 58 | 32 | 18.8 | 25.2 | 5.2 | 1.40 | 0.84 | 0.20 | 24 | 4.1 | 5.3 |
| 222 | 6 | 3 | 9 | 2 | 12 | 1627 | 58 | 15 | 20.0 | 8.8 | 5.6 | 2.00 | 0.72 | 0.28 | 31 | 4.2 | 5.7 |
| 223 | 6 | 3 | 9 | 2 | 13 | 1094 | 82 | 21 | 12.0 | 7.6 | 3.2 | 2.64 | 2.52 | 0.20 | 10 | 1.7 | 6.5 |
| 224 | 6 | 3 | 9 | 2 | 14 | 485 | 42 | 13 | 8.8 | 4.8 | 2.4 | 2.32 | 1.64 | 0.20 | 8 | 1.3 | 5.7 |
| 225 | 6 | 3 | 9 | 2 | 15 | 374 | 34 | 15 | 11.2 | 4.8 | 2.8 | 1.76 | 1.48 | 0.20 | 7 | 1.5 | 5.5 |
| 226 | 6 | 3 | 9 | 3 | 16 | 6360 | 155 | 10 | 24.4 | 8.8 | 0.4 | 1.16 | 0.08 | 0.08 | 2 | 2.6 | 7.5 |
| 227 | 6 | 3 | 9 | 3 | 17 | 1367 | 60 | 22 | 16.4 | 7.2 | 2.8 | 2.56 | 0.92 | 0.12 | 20 | 2.8 | 6.4 |
| 228 | 6 | 3 | 9 | 3 | 18 | 585 | 21 | 24 | 16.4 | 5.6 | 3.6 | 0.56 | 0.36 | 0.08 | 12 | 2.3 | 5.6 |
| 229 | 6 | 3 | 9 | 3 | 19 | 932 | 77 | 97 | 12.0 | 6.8 | 17.2 | 3.44 | 3.64 | 0.48 | 91 | 3.2 | 5.7 |
| 230 | 6 | 3 | 9 | 3 | 20 | 1380 | 91 | 56 | 12.8 | 7.6 | 3.2 | 2.84 | 2.56 | 0.12 | 41 | 5.4 | 5.7 |
| 231 | 6 | 3 | 9 | 3 | 21 | 1263 | 26 | 14 | 15.6 | 19.6 | 3.6 | 3.88 | 3.48 | 0.24 | 68 | 3.1 | 6.2 |
| 232 | 6 | 3 | 10 | 1 | 1 | 1121 | 93 | 14 | 14.0 | 6.8 | 23.2 | 0.92 | 0.64 | 0.12 | 160 | 4.4 | 6.1 |
| 233 | 6 | 3 | 10 | 1 | 2 | 1310 | 138 | 24 | 17.2 | 9.6 | 6.0 | 1.52 | 0.76 | 0.12 | 34 | 4.7 | 5.6 |
| 234 | 6 | 3 | 10 | 1 | 3 | 1592 | 146 | 51 | 9.6 | 14.0 | 4.0 | 1.40 | 0.68 | 0.08 | 37 | 3.8 | 5.7 |
| 235 | 6 | 3 | 10 | 1 | 4 | 1298 | 146 | 46 | 15.2 | 14.8 | 5.2 | 4.12 | 1.76 | 0.08 | 26 | 6.8 | 5.3 |
| 236 | 6 | 3 | 10 | 1 | 5 | 1309 | 106 | 28 | 13.2 | 12.4 | 3.6 | 1.04 | 0.76 | 0.08 | 21 | 6.4 | 5.2 |
| 237 | 6 | 3 | 10 | 1 | 6 | 1004 | 92 | 26 | 14.0 | 6.4 | 4.0 | 0.68 | 0.36 | 0.08 | 26 | 4.3 | 5.5 |
| 238 | 6 | 3 | 10 | 2 | 7 | 2309 | 119 | 58 | 10.8 | 27.6 | 5.2 | 4.84 | 2.84 | 0.16 | 60 | 5.6 | 6.4 |
| 239 | 6 | 3 | 10 | 2 | 8 | 1273 | 108 | 106 | 18.4 | 11.2 | 3.6 | 4.32 | 1.84 | 0.12 | 29 | 3.7 | 6.0 |
| 240 | 6 | 3 | 10 | 2 | 9 | 1576 | 96 | 36 | 8.0 | 16.0 | 2.4 | 4.20 | 1.16 | 0.08 | 32 | 4.3 | 6.6 |
| 241 | 6 | 3 | 10 | 2 | 10 | 732 | 44 | 15 | 14.0 | 10.0 | 4.4 | 1.64 | 0.76 | 0.12 | 16 | 3.0 | 5.5 |
| 242 | 6 | 3 | 10 | 2 | 11 | 362 | 36 | 23 | 10.0 | 5.6 | 2.8 | 1.64 | 1.28 | 0.16 | 8 | 1.3 | 5.9 |
| 243 | 6 | 3 | 10 | 2 | 12 | 252 | 34 | 21 | 7.6 | 4.8 | 2.4 | 1.16 | 1.48 | 0.16 | 6 | 1.1 | 5.8 |
| 244 | 6 | 3 | 10 | 2 | 13 | 345 | 53 | 24 | 11.2 | 5.6 | 2.4 | 2.24 | 2.20 | 0.16 | 7 | 1.3 | 5.7 |
| 245 | 6 | 3 | 10 | 2 | 14 | 842 | 66 | 14 | 10.4 | 6.4 | 3.2 | 2.52 | 0.72 | 0.12 | 15 | 4.1 | 5.5 |
| 246 | 6 | 3 | 10 | 2 | 15 | 524 | 25 | 10 | 14.0 | 7.2 | 4.0 | 2.84 | 1.64 | 0.28 | 10 | 1.9 | 5.5 |
| 247 | 6 | 3 | 10 | 3 | 16 | 964 | 49 | 52 | 9.6 | 14.4 | 3.2 | 3.28 | 4.40 | 0.20 | 19 | 2.9 | 6.1 |
| 248 | 6 | 3 | 10 | 3 | 17 | 494 | 30 | 19 | 9.2 | 8.4 | 2.0 | 3.28 | 1.20 | 0.08 | 8 | 1.5 | 6.0 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 249 | 6 | 3 | 10 | 3 | 18 | 823 | 74 | 38 | 8.8 | 10.0 | 4.8 | 3.04 | 1.80 | 0.04 | 17 | 3.5 | 5.4 |
| 250 | 6 | 3 | 10 | 3 | 19 | 1044 | 90 | 20 | 14.0 | 6.4 | 4.8 | 2.08 | 1.60 | 0.12 | 32 | 4.6 | 5.4 |
| 251 | 6 | 3 | 10 | 3 | 20 | 946 | 74 | 40 | 8.4 | 6.0 | 4.4 | 2.00 | 1.48 | 0.16 | 46 | 3.6 | 5.6 |
| 252 | 6 | 3 | 10 | 3 | 21 | 1743 | 44 | 18 | 13.2 | 36.0 | 5.2 | 5.32 | 4.12 | 0.32 | 165 | 3.2 | 6.1 |
| 253 | 6 | 3 | 11 | 1 | 1 | 1067 | 57 | 22 | 17.2 | 4.4 | 5.2 | 0.52 | 0.44 | 0.04 | 24 | 5.3 | 5.2 |
| 254 | 6 | 3 | 11 | 1 | 2 | 1152 | 72 | 27 | 15.2 | 3.2 | 4.0 | 0.32 | 0.28 | 0.04 | 27 | 3.9 | 5.6 |
| 255 | 6 | 3 | 11 | 1 | 3 | 947 | 80 | 44 | 18.4 | 6.0 | 3.6 | 2.32 | 1.00 | 0.08 | 18 | 5.0 | 5.4 |
| 256 | 6 | 3 | 11 | 1 | 4 | 1572 | 177 | 25 | 14.8 | 6.8 | 3.6 | 2.04 | 2.96 | 0.08 | 47 | 6.3 | 5.5 |
| 257 | 6 | 3 | 11 | 1 | 5 | 817 | 116 | 31 | 14.0 | 5.6 | 3.2 | 1.28 | 0.92 | 0.04 | 22 | 3.5 | 5.5 |
| 258 | 6 | 3 | 11 | 1 | 6 | 1048 | 114 | 78 | 12.8 | 6.4 | 2.8 | 1.32 | 1.36 | 0.08 | 82 | 4.4 | 5.7 |
| 259 | 6 | 3 | 11 | 2 | 7 | 1561 | 176 | 22 | 13.6 | 17.6 | 3.2 | 3.52 | 1.44 | 0.08 | 106 | 3.7 | 5.9 |
| 260 | 6 | 3 | 11 | 2 | 8 | 1283 | 107 | 43 | 12.4 | 18.4 | 4.0 | 3.08 | 1.40 | 0.08 | 128 | 4.4 | 6.0 |
| 261 | 6 | 3 | 11 | 2 | 9 | 996 | 119 | 19 | 12.0 | 15.2 | 5.2 | 4.08 | 2.88 | 0.36 | 105 | 4.0 | 6.0 |
| 262 | 6 | 3 | 11 | 2 | 10 | 1124 | 94 | 22 | 14.4 | 6.0 | 2.8 | 1.48 | 0.44 | 0.08 | 20 | 4.4 | 5.7 |
| 263 | 6 | 3 | 11 | 2 | 11 | 1645 | 100 | 25 | 28.4 | 8.0 | 4.4 | 1.44 | 0.84 | 0.32 | 26 | 4.2 | 5.6 |
| 264 | 6 | 3 | 11 | 2 | 12 | 874 | 132 | 26 | 13.6 | 6.8 | 4.4 | 0.80 | 0.56 | 0.08 | 18 | 5.2 | 5.3 |
| 265 | 6 | 3 | 11 | 2 | 13 | 552 | 87 | 28 | 12.0 | 6.4 | 1.6 | 3.44 | 3.36 | 0.20 | 7 | 1.4 | 5.9 |
| 266 | 6 | 3 | 11 | 2 | 14 | 606 | 89 | 29 | 10.4 | 4.8 | 1.6 | 3.56 | 6.40 | 0.20 | 8 | 1.8 | 6.3 |
| 267 | 6 | 3 | 11 | 2 | 15 | 599 | 85 | 20 | 12.4 | 4.8 | 2.0 | 3.36 | 3.12 | 0.20 | 9 | 2.3 | 5.8 |
| 268 | 6 | 3 | 11 | 3 | 16 | 1234 | 71 | 29 | 10.8 | 8.0 | 2.0 | 2.56 | 0.76 | 0.04 | 22 | 4.1 | 6.3 |
| 269 | 6 | 3 | 11 | 3 | 17 | 1156 | 97 | 37 | 12.8 | 5.2 | 2.4 | 6.28 | 2.12 | 0.12 | 19 | 3.8 | 6.0 |
| 270 | 6 | 3 | 11 | 3 | 18 | 972 | 98 | 43 | 12.4 | 8.8 | 3.2 | 4.48 | 4.56 | 0.08 | 16 | 4.3 | 5.7 |
| 271 | 6 | 3 | 11 | 3 | 19 | 1212 | 109 | 35 | 13.6 | 4.8 | 7.2 | 3.00 | 3.04 | 0.16 | 50 | 6.1 | 5.6 |
| 272 | 6 | 3 | 11 | 3 | 20 | 1502 | 88 | 18 | 12.0 | 4.4 | 3.2 | 3.68 | 2.68 | 0.16 | 42 | 3.8 | 5.9 |
| 273 | 6 | 3 | 11 | 3 | 21 | 2024 | 59 | 20 | 15.6 | 5.6 | 4.4 | 3.60 | 1.76 | 0.16 | 85 | 5.2 | 6.1 |
| 274 | 6 | 3 | 12 | 1 | 1 | 1488 | 112 | 24 | 14.4 | 9.6 | 4.0 | 3.48 | 1.76 | 0.08 | 55 | 3.7 | 5.9 |
| 275 | 6 | 3 | 12 | 1 | 2 | 1267 | 138 | 29 | 11.2 | 6.4 | 2.8 | 2.24 | 1.24 | 0.04 | 39 | 3.4 | 5.9 |
| 276 | 6 | 3 | 12 | 1 | 3 | 810 | 78 | 19 | 14.8 | 8.8 | 3.6 | 2.32 | 1.72 | 0.12 | 67 | 1.8 | 6.0 |
| 277 | 6 | 3 | 12 | 1 | 4 | 1089 | 109 | 18 | 13.6 | 6.0 | 4.4 | 2.32 | 1.56 | 0.08 | 103 | 3.9 | 5.6 |
| 278 | 6 | 3 | 12 | 1 | 5 | 519 | 56 | 18 | 10.4 | 7.2 | 17.6 | 1.68 | 1.00 | 0.12 | 215 | 2.6 | 5.8 |
| 279 | 6 | 3 | 12 | 1 | 6 | 350 | 51 | 21 | 13.2 | 9.2 | 17.6 | 2.20 | 1.08 | 0.16 | 205 | 2.6 | 8.6 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 280 | 6 | 3 | 12 | 2 | 7 | 1993 | 136 | 54 | 30.8 | 14.4 | 13.2 | 1.12 | 0.68 | 0.32 | 77 | 5.0 | 6.1 |
| 281 | 6 | 3 | 12 | 2 | 8 | 1006 | 130 | 31 | 14.0 | 9.6 | 3.6 | 2.52 | 1.56 | 0.48 | 16 | 4.2 | 6.2 |
| 282 | 6 | 3 | 12 | 2 | 9 | 835 | 104 | 50 | 14.0 | 25.2 | 6.8 | 1.96 | 1.48 | 0.32 | 18 | 3.6 | 5.7 |
| 283 | 6 | 3 | 12 | 2 | 10 | 966 | 87 | 23 | 18.4 | 7.2 | 3.6 | 1.56 | 0.92 | 0.12 | 17 | 3.6 | 5.5 |
| 284 | 6 | 3 | 12 | 2 | 11 | 929 | 104 | 32 | 24.8 | 7.6 | 5.6 | 0.88 | 1.04 | 0.20 | 30 | 3.4 | 5.4 |
| 285 | 6 | 3 | 12 | 2 | 12 | 1359 | 129 | 30 | 22.4 | 7.2 | 8.0 | 0.60 | 0.48 | 0.04 | 45 | 6.1 | 5.3 |
| 286 | 6 | 3 | 12 | 2 | 13 | 650 | 54 | 24 | 12.8 | 6.8 | 4.8 | 0.64 | 0.76 | 0.08 | 24 | 2.9 | 5.0 |
| 287 | 6 | 3 | 12 | 2 | 14 | 810 | 95 | 64 | 15.6 | 6.4 | 4.8 | 0.68 | 0.88 | 0.12 | 36 | 4.0 | 5.2 |
| 288 | 6 | 3 | 12 | 2 | 15 | 920 | 114 | 44 | 14.8 | 9.6 | 6.0 | 0.96 | 1.04 | 0.08 | 38 | 5.1 | 4.8 |
| 289 | 6 | 3 | 12 | 3 | 16 | 1447 | 39 | 42 | 14.0 | 25.6 | 8.4 | 1.80 | 2.12 | 0.56 | 40 | 6.2 | 5.2 |
| 290 | 6 | 3 | 12 | 3 | 17 | 1509 | 78 | 121 | 20.0 | 26.8 | 6.8 | 2.16 | 4.28 | 0.72 | 21 | 5.3 | 6.0 |
| 291 | 6 | 3 | 12 | 3 | 18 | 1320 | 58 | 40 | 14.4 | 8.0 | 5.6 | 1.52 | 1.92 | 0.32 | 26 | 5.2 | 5.7 |
| 292 | 6 | 3 | 12 | 3 | 19 | 1464 | 38 | 91 | 17.2 | 33.2 | 6.4 | 0.88 | 1.72 | 0.68 | 32 | 6.3 | 5.4 |
| 293 | 6 | 3 | 12 | 3 | 20 | 1330 | 40 | 52 | 15.6 | 30.0 | 5.6 | 0.88 | 1.48 | 0.56 | 30 | 5.5 | 5.6 |
| 294 | 6 | 3 | 12 | 3 | 21 | 1895 | 41 | 84 | 24.4 | 18.0 | 8.0 | 0.80 | 2.20 | 0.96 | 66 | 6.3 | 5.4 |
| 295 | 6 | 4 | 1 | 1 | 1 | 1400 | 145 | 17 | 16.0 | 30.8 | 4.4 | 3.00 | 2.68 | 0.64 | 41 | 4.7 | 5.8 |
| 296 | 6 | 4 | 1 | 1 | 2 | 1192 | 171 | 24 | 11.6 | 9.2 | 4.8 | 1.64 | 1.20 | 0.40 | 26 | 4.8 | 5.6 |
| 297 | 6 | 4 | 1 | 1 | 3 | 892 | 85 | 30 | 8.4 | 10.0 | 3.2 | 1.08 | 1.20 | 0.36 | 17 | 4.0 | 5.6 |
| 298 | 6 | 4 | 1 | 1 | 4 | 876 | 70 | 32 | 8.0 | 6.8 | 3.6 | 0.96 | 1.64 | 0.28 | 27 | 3.3 | 5.7 |
| 299 | 6 | 4 | 1 | 1 | 5 | 644 | 87 | 44 | 8.0 | 9.6 | 2.8 | 2.32 | 2.44 | 0.24 | 12 | 2.1 | 5.8 |
| 300 | 6 | 4 | 1 | 1 | 6 | 532 | 86 | 23 | 8.4 | 7.6 | 3.6 | 1.28 | 2.76 | 0.20 | 9 | 2.6 | 5.5 |
| 301 | 6 | 4 | 1 | 2 | 7 | 1028 | 108 | 26 | 11.2 | 8.4 | 6.4 | 1.00 | 1.24 | 0.28 | 28 | 2.8 | 5.6 |
| 302 | 6 | 4 | 1 | 2 | 8 | 792 | 128 | 19 | 8.8 | 18.4 | 7.2 | 3.48 | 1.84 | 0.16 | 165 | 3.5 | 5.8 |
| 303 | 6 | 4 | 1 | 2 | 9 | 1720 | 228 | 47 | 11.2 | 24.0 | 8.4 | 3.64 | 1.16 | 0.20 | 313 | 4.9 | 6.4 |
| 304 | 6 | 4 | 1 | 2 | 10 | 1064 | 142 | 37 | 16.0 | 13.6 | 4.8 | 2.64 | 1.48 | 0.16 | 25 | 4.4 | 5.5 |
| 305 | 6 | 4 | 1 | 2 | 11 | 932 | 86 | 22 | 15.6 | 7.6 | 6.0 | 0.76 | 0.68 | 0.40 | 32 | 3.3 | 5.6 |
| 306 | 6 | 4 | 1 | 2 | 12 | 1736 | 117 | 57 | 26.0 | 21.6 | 7.6 | 3.92 | 4.76 | 0.76 | 31 | 3.8 | 5.7 |
| 307 | 6 | 4 | 1 | 2 | 13 | 704 | 83 | 35 | 8.4 | 10.8 | 4.0 | 3.92 | 2.40 | 0.32 | 12 | 2.2 | 5.7 |
| 308 | 6 | 4 | 1 | 2 | 14 | 10 | 10 | 10 | 6.8 | 0.4 | 0.8 | 0.10 | 0.80 | 0.12 | 0 | 1.4 | 6.6 |
| 309 | 6 | 4 | 1 | 2 | 15 | 564 | 58 | 22 | 6.8 | 6.0 | 2.8 | 2.00 | 1.68 | 0.20 | 9 | 1.3 | 6.1 |
| 310 | 6 | 4 | 1 | 3 | 16 | 404 | 38 | 19 | 6.4 | 5.2 | 2.8 | 1.60 | 1.56 | 0.20 | 8 | 4.6 | 5.5 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 311 | 6 | 4 | 1 | 3 | 17 | 2576 | 89 | 78 | 19.6 | 30.0 | 14.4 | 2.64 | 2.88 | 2.72 | 60 | 5.9 | 5.5 |
| 312 | 6 | 4 | 1 | 3 | 18 | 1708 | 48 | 47 | 14.4 | 18.8 | 7.6 | 1.24 | 2.08 | 0.60 | 27 | 6.0 | 6.1 |
| 313 | 6 | 4 | 1 | 3 | 19 | 2332 | 79 | 70 | 19.6 | 73.2 | 9.6 | 1.48 | 2.52 | 0.56 | 44 | 8.3 | 5.7 |
| 314 | 6 | 4 | 1 | 3 | 20 | 1604 | 54 | 50 | 12.0 | 69.2 | 9.6 | 1.76 | 2.88 | 1.08 | 30 | 5.0 | 5.7 |
| 315 | 6 | 4 | 1 | 3 | 21 | 4824 | 157 | 64 | 15.2 | 49.2 | 4.0 | 1.88 | 1.84 | 0.52 | 26 | 4.9 | 6.3 |
| 316 | 6 | 4 | 2 | 1 | 1 | 1516 | 225 | 42 | 12.8 | 10.0 | 4.8 | 1.32 | 1.04 | 0.08 | 36 | 4.9 | 5.9 |
| 317 | 6 | 4 | 2 | 1 | 2 | 1292 | 157 | 38 | 11.2 | 12.0 | 4.0 | 2.16 | 1.76 | 0.12 | 27 | 4.5 | 5.4 |
| 318 | 6 | 4 | 2 | 1 | 3 | 820 | 90 | 57 | 11.2 | 9.6 | 4.8 | 0.96 | 1.24 | 0.08 | 18 | 3.9 | 5.4 |
| 319 | 6 | 4 | 2 | 1 | 4 | 840 | 139 | 36 | 8.0 | 7.6 | 3.6 | 1.20 | 1.00 | 0.08 | 17 | 3.2 | 5.5 |
| 320 | 6 | 4 | 2 | 1 | 5 | 716 | 143 | 31 | 9.2 | 9.2 | 3.6 | 2.16 | 1.64 | 0.08 | 13 | 3.0 | 5.6 |
| 321 | 6 | 4 | 2 | 1 | 6 | 1180 | 195 | 17 | 7.6 | 8.4 | 2.8 | 2.88 | 0.64 | 0.08 | 18 | 3.2 | 6.1 |
| 322 | 6 | 4 | 2 | 2 | 7 | 1456 | 194 | 42 | 10.8 | 11.2 | 4.0 | 1.80 | 0.52 | 0.08 | 33 | 3.0 | 6.3 |
| 323 | 6 | 4 | 2 | 2 | 8 | 540 | 53 | 23 | 7.6 | 6.4 | 4.8 | 0.56 | 0.52 | 0.08 | 18 | 3.0 | 5.5 |
| 324 | 6 | 4 | 2 | 2 | 9 | 740 | 80 | 21 | 8.8 | 7.6 | 4.8 | 0.32 | 0.48 | 0.12 | 16 | 2.0 | 5.3 |
| 325 | 6 | 4 | 2 | 2 | 10 | 1108 | 84 | 29 | 10.8 | 16.4 | 5.2 | 1.88 | 0.84 | 0.16 | 17 | 3.2 | 5.6 |
| 326 | 6 | 4 | 2 | 2 | 11 | 1108 | 85 | 27 | 15.6 | 18.8 | 6.0 | 3.64 | 1.92 | 0.24 | 14 | 2.1 | 5.4 |
| 327 | 6 | 4 | 2 | 2 | 12 | 860 | 70 | 19 | 11.6 | 10.8 | 4.8 | 0.40 | 0.84 | 0.36 | 18 | 3.4 | 5.3 |
| 328 | 6 | 4 | 2 | 2 | 13 | 4880 | 51 | 21 | 46.4 | 103.2 | 5.6 | 7.28 | 6.00 | 0.28 | 21 | 2.0 | 7.1 |
| 329 | 6 | 4 | 2 | 2 | 14 | 316 | 56 | 29 | 8.8 | 8.0 | 4.8 | 2.24 | 3.40 | 0.24 | 7 | 1.4 | 5.5 |
| 330 | 6 | 4 | 2 | 2 | 15 | 440 | 33 | 26 | 8.8 | 8.8 | 7.6 | 4.08 | 3.16 | 0.76 | 15 | 1.3 | 5.3 |
| 331 | 6 | 4 | 2 | 3 | 16 | 1420 | 70 | 49 | 15.2 | 17.6 | 11.6 | 0.72 | 1.28 | 0.24 | 36 | 5.2 | 5.1 |
| 332 | 6 | 4 | 2 | 3 | 17 | 1084 | 65 | 62 | 15.6 | 16.4 | 9.2 | 0.44 | 0.88 | 0.16 | 38 | 5.3 | 5.1 |
| 333 | 6 | 4 | 2 | 3 | 18 | 1356 | 44 | 41 | 13.2 | 16.0 | 9.6 | 0.48 | 0.76 | 0.24 | 47 | 5.9 | 5.0 |
| 334 | 6 | 4 | 2 | 3 | 19 | 996 | 66 | 60 | 11.6 | 14.4 | 7.2 | 0.84 | 1.08 | 0.08 | 27 | 4.9 | 5.0 |
| 335 | 6 | 4 | 2 | 3 | 20 | 648 | 28 | 57 | 17.2 | 14.0 | 8.8 | 0.20 | 0.64 | 0.28 | 26 | 4.8 | 4.8 |
| 336 | 6 | 4 | 2 | 3 | 21 | 784 | 50 | 32 | 35.6 | 15.6 | 10.4 | 0.24 | 0.60 | 0.20 | 36 | 4.9 | 4.8 |
| 337 | 6 | 4 | 3 | 1 | 1 | 996 | 155 | 38 | 19.2 | 13.6 | 4.8 | 1.72 | 1.32 | 0.12 | 26 | 4.0 | 5.5 |
| 338 | 6 | 4 | 3 | 1 | 2 | 1104 | 152 | 32 | 12.0 | 8.8 | 3.2 | 7.72 | 3.76 | 0.16 | 25 | 4.8 | 5.6 |
| 339 | 6 | 4 | 3 | 1 | 3 | 992 | 134 | 28 | 9.6 | 8.4 | 3.2 | 6.92 | 3.36 | 0.20 | 22 | 2.1 | 5.9 |
| 340 | 6 | 4 | 3 | 1 | 4 | 15 | 254 | 31 | 14.0 | 10.8 | 3.2 | 4.20 | 2.48 | 0.12 | 24 | 3.8 | 6.0 |
| 341 | 6 | 4 | 3 | 1 | 5 | 1104 | 248 | 131 | 19.2 | 8.8 | 3.6 | 1.72 | 1.88 | 0.08 | 25 | 4.9 | 5.9 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 342 | 6 | 4 | 3 | 1 | 6 | 808 | 162 | 108 | 22.4 | 8.4 | 4.4 | 1.44 | 1.28 | 0.08 | 32 | 3.0 | 5.8 |
| 343 | 6 | 4 | 3 | 2 | 7 | 2020 | 176 | 26 | 16.0 | 20.4 | 3.6 | 3.36 | 1.00 | 0.08 | 197 | 5.1 | 6.2 |
| 344 | 6 | 4 | 3 | 2 | 8 | 1028 | 213 | 72 | 21.6 | 83.2 | 29.6 | 17.48 | 4.36 | 0.32 | 796 | 3.4 | 5.8 |
| 345 | 6 | 4 | 3 | 2 | 9 | 424 | 91 | 29 | 15.6 | 11.2 | 7.6 | 2.92 | 2.04 | 0.08 | 98 | 3.8 | 5.4 |
| 346 | 6 | 4 | 3 | 2 | 10 | 616 | 57 | 31 | 16.0 | 124.0 | 6.8 | 2.12 | 1.86 | 0.16 | 16 | 2.9 | 5.1 |
| 347 | 6 | 4 | 3 | 2 | 11 | 1320 | 65 | 23 | 20.4 | 154.0 | 8.4 | 4.08 | 0.76 | 1.40 | 48 | 2.8 | 5.4 |
| 348 | 6 | 4 | 3 | 2 | 12 | 676 | 75 | 31 | 17.6 | 13.6 | 5.2 | 5.20 | 1.88 | 0.28 | 16 | 2.9 | 5.3 |
| 349 | 6 | 4 | 3 | 2 | 13 | 4480 | 55 | 111 | 87.2 | 100.8 | 19.2 | 9.00 | 16.32 | 3.20 | 57 | 1.9 | 6.5 |
| 350 | 6 | 4 | 3 | 2 | 14 | 812 | 150 | 102 | 8.4 | 8.8 | 2.8 | 5.16 | 5.28 | 0.44 | 1414 | 2.1 | 6.3 |
| 351 | 6 | 4 | 3 | 2 | 15 | 840 | 99 | 42 | 9.2 | 11.2 | 4.0 | 4.32 | 3.60 | 0.20 | 20 | 2.6 | 5.8 |
| 352 | 6 | 4 | 3 | 3 | 16 | 1440 | 65 | 76 | 18.0 | 34.0 | 8.0 | 2.20 | 4.68 | 0.96 | 26 | 5.4 | 5.7 |
| 353 | 6 | 4 | 3 | 3 | 17 | 1056 | 61 | 96 | 30.4 | 16.4 | 7.2 | 1.24 | 22.36 | 0.24 | 26 | 4.2 | 5.4 |
| 354 | 6 | 4 | 3 | 3 | 18 | 1436 | 139 | 50 | 27.6 | 21.6 | 9.6 | 1.12 | 2.76 | 0.28 | 43 | 11.4 | 4.9 |
| 355 | 6 | 4 | 3 | 3 | 19 | 2972 | 88 | 79 | 18.0 | 43.6 | 6.8 | 1.00 | 1.20 | 0.36 | 40 | 4.6 | 6.2 |
| 356 | 6 | 4 | 3 | 3 | 20 | 2324 | 82 | 41 | 15.6 | 30.0 | 6.0 | 1.04 | 1.92 | 0.56 | 43 | 5.9 | 5.9 |
| 357 | 6 | 4 | 3 | 3 | 21 | 2920 | 50 | 69 | 36.8 | 95.2 | 6.8 | 0.96 | 3.84 | 0.64 | 88 | 9.5 | 5.6 |
| 358 | 6 | 4 | 4 | 1 | 1 | 992 | 74 | 22 | 16.0 | 12.4 | 18.4 | 2.44 | 1.68 | 0.16 | 261 | 2.3 | 5.8 |
| 359 | 6 | 4 | 4 | 1 | 2 | 436 | 52 | 40 | 30.4 | 6.4 | 16.4 | 0.72 | 0.92 | 0.16 | 204 | 2.2 | 5.6 |
| 360 | 6 | 4 | 4 | 1 | 3 | 616 | 62 | 22 | 6.8 | 5.6 | 2.8 | 1.60 | 1.00 | 0.08 | 43 | 1.9 | 5.8 |
| 361 | 6 | 4 | 4 | 1 | 4 | 1224 | 79 | 14 | 10.4 | 8.8 | 6.8 | 2.56 | 1.28 | 0.12 | 32 | 2.0 | 5.6 |
| 362 | 6 | 4 | 4 | 1 | 5 | 660 | 51 | 13 | 13.6 | 4.8 | 10.0 | 0.28 | 0.32 | 0.04 | 47 | 3.1 | 5.2 |
| 363 | 6 | 4 | 4 | 1 | 6 | 808 | 65 | 120 | 11.2 | 4.8 | 5.2 | 0.68 | 0.52 | 0.04 | 26 | 3.0 | 6.0 |
| 364 | 6 | 4 | 4 | 2 | 7 | 868 | 41 | 12 | 8.0 | 6.4 | 4.0 | 1.36 | 0.88 | 0.08 | 21 | 2.0 | 5.8 |
| 365 | 6 | 4 | 4 | 2 | 8 | 636 | 44 | 21 | 7.6 | 8.4 | 5.6 | 0.72 | 0.48 | 0.12 | 46 | 2.2 | 5.5 |
| 366 | 6 | 4 | 4 | 2 | 9 | 2696 | 184 | 50 | 20.4 | 32.0 | 12.4 | 3.92 | 2.12 | 0.21 | 142 | 2.5 | 5.6 |
| 367 | 6 | 4 | 4 | 2 | 10 | 1656 | 118 | 26 | 29.2 | 13.2 | 22.8 | 0.60 | 0.60 | 0.12 | 96 | 1.8 | 5.5 |
| 368 | 6 | 4 | 4 | 2 | 11 | 524 | 35 | 7 | 8.0 | 3.2 | 7.6 | 0.28 | 0.16 | 0.16 | 29 | 1.2 | 5.7 |
| 369 | 6 | 4 | 4 | 2 | 12 | 748 | 66 | 19 | 15.6 | 8.4 | 8.4 | 0.68 | 0.56 | 0.08 | 32 | 1.7 | 5.3 |
| 370 | 6 | 4 | 4 | 2 | 13 | 608 | 268 | 10 | 7.2 | 6.4 | 4.0 | 1.44 | 1.28 | 0.36 | 17 | 1.8 | 5.6 |
| 371 | 6 | 4 | 4 | 2 | 14 | 708 | 31 | 10 | 7.2 | 6.4 | 4.0 | 0.84 | 0.80 | 0.12 | 17 | 2.2 | 5.4 |
| 372 | 6 | 4 | 4 | 2 | 15 | 1204 | 201 | 49 | 69.6 | 24.8 | 33.6 | 0.56 | 1.24 | 0.16 | 699 | 10.4 | 4.7 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 373 | 6 | 4 | 4 | 3 | 16 | 848 | 58 | 13 | 6.8 | 7.2 | 3.6 | 2.12 | 0.88 | 0.04 | 19 | 1.9 | 5.7 |
| 374 | 6 | 4 | 4 | 3 | 17 | 448 | 34 | 13 | 6.0 | 5.2 | 2.8 | 1.52 | 0.72 | 0.08 | 10 | 1.4 | 5.6 |
| 375 | 6 | 4 | 4 | 3 | 18 | 1072 | 78 | 28 | 16.0 | 12.8 | 7.2 | 5.48 | 3.24 | 0.32 | 20 | 1.1 | 5.7 |
| 376 | 6 | 4 | 4 | 3 | 19 | 1360 | 76 | 19 | 16.0 | 10.8 | 32.0 | 3.72 | 6.72 | 0.48 | 204 | 1.8 | 5.8 |
| 377 | 6 | 4 | 4 | 3 | 20 | 1792 | 89 | 28 | 17.2 | 15.2 | 32.0 | 5.08 | 6.60 | 0.40 | 114 | 1.8 | 5.8 |
| 378 | 6 | 4 | 4 | 3 | 21 | 1692 | 62 | 22 | 15.6 | 20.8 | 10.8 | 9.44 | 2.48 | 0.32 | 68 | 1.2 | 6.2 |
| 379 | 6 | 4 | 5 | 1 | 1 | 808 | 102 | 20 | 11.6 | 6.0 | 3.6 | 1.16 | 5.60 | 0.08 | 20 | 3.0 | 5.5 |
| 380 | 6 | 4 | 5 | 1 | 2 | 1852 | 153 | 42 | 18.8 | 8.8 | 6.0 | 2.56 | 3.48 | 0.20 | 40 | 3.3 | 5.7 |
| 381 | 6 | 4 | 5 | 1 | 3 | 600 | 135 | 44 | 15.2 | 13.2 | 8.0 | 7.56 | 14.52 | 0.44 | 33 | 3.0 | 5.3 |
| 382 | 6 | 4 | 5 | 1 | 4 | 1556 | 187 | 91 | 22.8 | 13.2 | 7.2 | 1.76 | 2.68 | 0.20 | 54 | 3.0 | 5.7 |
| 383 | 6 | 4 | 5 | 1 | 5 | 1620 | 188 | 40 | 21.6 | 15.6 | 6.0 | 2.68 | 2.56 | 0.12 | 44 | 3.1 | 5.9 |
| 384 | 6 | 4 | 5 | 1 | 6 | 1496 | 200 | 45 | 23.2 | 11.2 | 6.0 | 1.52 | 4.00 | 0.24 | 30 | 2.7 | 5.7 |
| 385 | 6 | 4 | 5 | 2 | 7 | 1472 | 213 | 84 | 29.2 | 44.0 | 13.2 | 9.12 | 3.36 | 0.36 | 243 | 2.2 | 6.1 |
| 386 | 6 | 4 | 5 | 2 | 8 | 1492 | 524 | 292 | 48.0 | 80.8 | 30.0 | 19.24 | 24.52 | 0.76 | 488 | 3.2 | 6.1 |
| 387 | 6 | 4 | 5 | 2 | 9 | 928 | 154 | 61 | 16.0 | 18.4 | 8.0 | 6.80 | 3.56 | 0.12 | 106 | 2.6 | 5.5 |
| 388 | 6 | 4 | 5 | 2 | 10 | 448 | 61 | 17 | 8.0 | 6.0 | 4.0 | 0.88 | 2.24 | 0.12 | 18 | 2.3 | 4.5 |
| 389 | 6 | 4 | 5 | 2 | 11 | 1012 | 205 | 34 | 18.0 | 15.2 | 6.4 | 2.76 | 7.32 | 0.20 | 24 | 3.0 | 4.8 |
| 390 | 6 | 4 | 5 | 2 | 12 | 1220 | 159 | 40 | 14.0 | 12.0 | 8.0 | 1.96 | 1.52 | 0.24 | 40 | 3.9 | 4.8 |
| 391 | 6 | 4 | 5 | 2 | 13 | 488 | 40 | 22 | 8.0 | 7.6 | 8.0 | 1.32 | 1.60 | 0.12 | 25 | 2.4 | 4.7 |
| 392 | 6 | 4 | 5 | 2 | 14 | 892 | 59 | 25 | 16.4 | 9.6 | 11.6 | 1.24 | 1.56 | 0.16 | 38 | 5.0 | 4.5 |
| 393 | 6 | 4 | 5 | 2 | 15 | 824 | 65 | 23 | 13.2 | 8.8 | 7.6 | 1.16 | 1.60 | 0.16 | 36 | 3.6 | 4.6 |
| 394 | 6 | 4 | 5 | 3 | 16 | 1400 | 72 | 58 | 26.0 | 18.8 | 47.6 | 1.20 | 3.16 | 0.88 | 58 | 4.7 | 4.7 |
| 395 | 6 | 4 | 5 | 3 | 17 | 1192 | 55 | 51 | 16.0 | 13.2 | 7.2 | 1.92 | 2.56 | 0.28 | 28 | 4.6 | 5.2 |
| 396 | 6 | 4 | 5 | 3 | 18 | 1280 | 58 | 46 | 220.0 | 14.0 | 8.4 | 1.40 | 2.84 | 0.40 | 30 | 4.7 | 4.9 |
| 397 | 6 | 4 | 5 | 3 | 19 | 680 | 1 | 4 | 0.8 | 0.8 | 0.0 | 0.00 | 0.00 | 0.12 | 0 | 3.6 | 5.3 |
| 398 | 6 | 4 | 5 | 3 | 20 | 1280 | 22 | 27 | 14.4 | 49.2 | 8.4 | 0.80 | 1.48 | 0.96 | 63 | 5.2 | 5.1 |
| 399 | 6 | 4 | 5 | 3 | 21 | 1436 | 28 | 36 | 20.0 | 67.2 | 8.0 | 0.60 | 1.60 | 0.92 | 63 | 5.8 | 5.1 |
| 400 | 6 | 4 | 6 | 1 | 1 | 5120 | 146 | 22 | 11.2 | 24.8 | 1.6 | 4.68 | 1.88 | 0.12 | 31 | 2.7 | 6.0 |
| 401 | 6 | 4 | 6 | 1 | 2 | 1280 | 92 | 19 | 10.4 | 9.2 | 3.6 | 2.48 | 1.68 | 0.08 | 40 | 3.5 | 5.1 |
| 402 | 6 | 4 | 6 | 1 | 3 | 504 | 111 | 61 | 30.4 | 12.4 | 15.6 | 0.36 | 0.44 | 0.04 | 358 | 8.1 | 5.7 |
| 403 | 6 | 4 | 6 | 1 | 4 | 1244 | 159 | 26 | 12.8 | 13.2 | 2.8 | 1.88 | 1.12 | 0.12 | 30 | 3.1 | 5.5 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 404 | 6 | 4 | 6 | 1 | 5 | 800 | 122 | 50 | 8.0 | 9.2 | 3.2 | 1.16 | 0.96 | 0.04 | 22 | 3.3 | 5.7 |
| 405 | 6 | 4 | 6 | 1 | 6 | 920 | 97 | 18 | 10.8 | 9.2 | 6.0 | 1.56 | 0.88 | 0.08 | 97 | 3.2 | 6.1 |
| 406 | 6 | 4 | 6 | 2 | 7 | 1268 | 111 | 28 | 14.8 | 14.4 | 3.2 | 1.60 | 0.48 | 0.08 | 137 | 3.5 | 6.3 |
| 407 | 6 | 4 | 6 | 2 | 8 | 1800 | 135 | 37 | 13.2 | 21.2 | 2.8 | 3.24 | 1.20 | 0.04 | 122 | 4.0 | 5.6 |
| 408 | 6 | 4 | 6 | 2 | 9 | 936 | 190 | 184 | 20.4 | 23.6 | 14.8 | 6.44 | 7.24 | 0.28 | 139 | 3.9 | 5.2 |
| 409 | 6 | 4 | 6 | 2 | 10 | 828 | 61 | 24 | 15.2 | 10.4 | 13.2 | 0.16 | 0.32 | 0.04 | 62 | 4.0 | 5.2 |
| 410 | 6 | 4 | 6 | 2 | 11 | 984 | 83 | 23 | 14.0 | 12.4 | 10.8 | 0.40 | 0.28 | 0.08 | 54 | 4.3 | 5.3 |
| 411 | 6 | 4 | 6 | 2 | 12 | 1312 | 157 | 32 | 16.0 | 19.6 | 4.8 | 0.96 | 0.44 | 0.20 | 33 | 4.4 | 5.0 |
| 412 | 6 | 4 | 6 | 2 | 13 | 632 | 47 | 33 | 13.6 | 12.4 | 8.8 | 1.72 | 1.52 | 0.12 | 32 | 3.0 | 5.1 |
| 413 | 6 | 4 | 6 | 2 | 14 | 656 | 49 | 30 | 14.8 | 13.6 | 8.4 | 0.92 | 1.76 | 0.24 | 42 | 4.0 | 5.0 |
| 414 | 6 | 4 | 6 | 2 | 15 | 836 | 38 | 32 | 22.8 | 16.8 | 9.2 | 0.28 | 0.92 | 0.16 | 49 | 4.3 | 5.4 |
| 415 | 6 | 4 | 6 | 3 | 16 | 1300 | 72 | 91 | 18.0 | 28.8 | 6.8 | 1.64 | 2.68 | 0.28 | 36 | 5.1 | 5.6 |
| 416 | 6 | 4 | 6 | 3 | 17 | 1196 | 83 | 64 | 12.8 | 18.8 | 6.0 | 1.64 | 2.40 | 0.12 | 28 | 4.0 | 5.0 |
| 417 | 6 | 4 | 6 | 3 | 18 | 1388 | 49 | 62 | 22.8 | 18.8 | 12.8 | 0.96 | 2.00 | 0.20 | 38 | 5.7 | 6.1 |
| 418 | 6 | 4 | 6 | 3 | 19 | 1684 | 58 | 203 | 34.8 | 39.6 | 7.2 | 1.48 | 2.32 | 1.08 | 33 | 4.0 | 6.3 |
| 419 | 6 | 4 | 6 | 3 | 20 | 1924 | 90 | 58 | 17.2 | 80.8 | 4.8 | 2.40 | 2.32 | 0.64 | 28 | 3.9 | 5.5 |
| 420 | 6 | 4 | 6 | 3 | 21 | 1356 | 18 | 31 | 14.0 | 61.2 | 5.2 | 0.40 | 1.20 | 0.56 | 37 | 3.8 | 5.8 |
| 421 | 6 | 4 | 7 | 1 | 1 | 2088 | 332 | 186 | 25.6 | 8.8 | 2.4 | 1.64 | 1.64 | 0.08 | 30 | 8.3 | 5.9 |
| 422 | 6 | 4 | 7 | 1 | 2 | 1708 | 278 | 23 | 10.8 | 10.0 | 3.6 | 4.72 | 3.00 | 0.16 | 78 | 3.9 | 4.7 |
| 423 | 6 | 4 | 7 | 1 | 3 | 520 | 327 | 353 | 158.4 | 14.4 | 11.6 | 1.32 | 1.36 | 0.04 | 162 | 14.0 | 5.1 |
| 424 | 6 | 4 | 7 | 1 | 4 | 45 | 108 | 40 | 10.4 | 6.0 | 4.4 | 2.56 | 4.72 | 0.32 | 17 | 2.6 | 5.1 |
| 425 | 6 | 4 | 7 | 1 | 5 | 372 | 113 | 84 | 8.0 | 8.0 | 2.9 | 3.56 | 4.40 | 0.12 | 264 | 2.3 | 5.1 |
| 426 | 6 | 4 | 7 | 1 | 6 | 976 | 177 | 25 | 7.2 | 9.6 | 2.4 | 6.12 | 2.68 | 0.08 | 264 | 3.1 | 5.5 |
| 427 | 6 | 4 | 7 | 2 | 7 | 894 | 139 | 22 | 11.2 | 10.4 | 3.2 | 4.52 | 1.80 | 0.08 | 170 | 2.9 | 5.8 |
| 428 | 6 | 4 | 7 | 2 | 8 | 833 | 157 | 35 | 10.4 | 37.2 | 7.2 | 6.92 | 3.00 | 0.08 | 94 | 2.4 | 6.2 |
| 429 | 6 | 4 | 7 | 2 | 9 | 1655 | 200 | 70 | 8.4 | 13.6 | 2.8 | 3.72 | 2.28 | 0.04 | 21 | 3.6 | 5.5 |
| 430 | 6 | 4 | 7 | 2 | 10 | 1174 | 133 | 21 | 11.2 | 8.0 | 2.4 | 2.44 | 0.40 | 0.04 | 22 | 3.6 | 5.3 |
| 431 | 6 | 4 | 7 | 2 | 11 | 829 | 80 | 24 | 11.2 | 6.4 | 3.6 | 0.32 | 0.56 | 0.04 | 27 | 3.7 | 5.3 |
| 432 | 6 | 4 | 7 | 2 | 12 | 778 | 668 | 25 | 16.8 | 7.2 | 3.6 | 0.28 | 0.64 | 0.04 | 27 | 3.1 | 6.2 |
| 433 | 6 | 4 | 7 | 2 | 13 | 1029 | 78 | 26 | 8.4 | 6.4 | 2.0 | 2.12 | 3.72 | 0.12 | 10 | 1.6 | 6.7 |
| 434 | 6 | 4 | 7 | 2 | 14 | 648 | 44 | 19 | 4.8 | 5.2 | 1.6 | 2.72 | 1.80 | 0.08 | 8 | 1.0 | 6.4 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 435 | 6 | 4 | 7 | 2 | 15 | 582 | 48 | 20 | 6.8 | 4.4 | 2.0 | 1.86 | 2.24 | 0.12 | 10 | 1.1 | 6.1 |
| 436 | 6 | 4 | 7 | 3 | 16 | 1928 | 93 | 64 | 15.2 | 50.8 | 4.4 | 2.16 | 3.40 | 0.44 | 34 | 7.9 | 6.4 |
| 437 | 6 | 4 | 7 | 3 | 17 | 1751 | 38 | 35 | 10.4 | 58.4 | 3.2 | 3.20 | 3.36 | 0.32 | 25 | 3.2 | 6.2 |
| 438 | 6 | 4 | 7 | 3 | 18 | 2352 | 108 | 69 | 18.0 | 76.0 | 4.4 | 3.56 | 3.84 | 0.36 | 32 | 5.9 | 5.9 |
| 439 | 6 | 4 | 7 | 3 | 19 | 2368 | 48 | 38 | 24.0 | 190.0 | 7.2 | 1.20 | 3.76 | 0.88 | 79 | 5.5 | 6.0 |
| 440 | 6 | 4 | 7 | 3 | 20 | 2480 | 141 | 100 | 33.2 | 199.6 | 10.0 | 4.40 | 8.24 | 1.00 | 89 | 5.8 | 5.9 |
| 441 | 6 | 4 | 7 | 3 | 21 | 2212 | 40 | 69 | 16.8 | 102.4 | 4.4 | 2.16 | 4.36 | 1.04 | 52 | 4.9 | 5.1 |
| 442 | 6 | 4 | 8 | 1 | 1 | 648 | 250 | 170 | 113.2 | 15.2 | 12.4 | 1.24 | 1.88 | 1.40 | 222 | 7.9 | 4.5 |
| 443 | 6 | 4 | 8 | 1 | 2 | 422 | 176 | 62 | 53.6 | 11.6 | 17.2 | 0.72 | 1.48 | 0.56 | 203 | 13.7 | 5.3 |
| 444 | 6 | 4 | 8 | 1 | 3 | 1324 | 190 | 36 | 11.6 | 8.8 | 3.6 | 1.88 | 3.60 | 0.44 | 52 | 5.1 | 5.7 |
| 445 | 6 | 4 | 8 | 1 | 4 | 1199 | 123 | 15 | 8.0 | 5.6 | 4.0 | 1.72 | 1.16 | 0.24 | 75 | 3.2 | 6.2 |
| 446 | 6 | 4 | 8 | 1 | 5 | 1962 | 303 | 30 | 10.4 | 8.0 | 2.4 | 3.96 | 1.16 | 0.20 | 57 | 9.5 | 6.6 |
| 447 | 6 | 4 | 8 | 1 | 6 | 1949 | 268 | 27 | 11.2 | 11.6 | 2.4 | 6.12 | 3.80 | 0.20 | 43 | 3.8 | 6.5 |
| 448 | 6 | 4 | 8 | 2 | 7 | 1992 | 215 | 87 | 10.8 | 10.4 | 2.8 | 2.84 | 1.16 | 0.16 | 198 | 4.6 | 6.0 |
| 449 | 6 | 4 | 8 | 2 | 8 | 838 | 157 | 53 | 9.6 | 30.4 | 8.8 | 10.68 | 3.56 | 0.24 | 196 | 3.3 | 6.1 |
| 450 | 6 | 4 | 8 | 2 | 9 | 1515 | 285 | 82 | 18.4 | 48.8 | 19.2 | 15.80 | 5.48 | 0.56 | 492 | 3.0 | 5.3 |
| 451 | 6 | 4 | 8 | 2 | 10 | 703 | 65 | 18 | 8.8 | 9.6 | 4.4 | 1.68 | 0.56 | 0.16 | 22 | 2.8 | 5.6 |
| 452 | 6 | 4 | 8 | 2 | 11 | 994 | 186 | 114 | 18.4 | 8.4 | 3.6 | 1.60 | 0.80 | 0.12 | 24 | 4.9 | 5.3 |
| 453 | 6 | 4 | 8 | 2 | 12 | 1264 | 149 | 28 | 13.6 | 9.2 | 3.2 | 2.04 | 0.36 | 0.04 | 22 | 5.0 | 5.5 |
| 454 | 6 | 4 | 8 | 2 | 13 | 549 | 80 | 31 | 8.0 | 4.8 | 3.2 | 1.80 | 0.56 | 0.04 | 12 | 1.9 | 5.7 |
| 455 | 6 | 4 | 8 | 2 | 14 | 1261 | 112 | 47 | 11.2 | 8.8 | 5.2 | 3.16 | 1.68 | 0.24 | 23 | 1.5 | 5.3 |
| 456 | 6 | 4 | 8 | 2 | 15 | 728 | 112 | 86 | 27.6 | 72.4 | 7.2 | 4.12 | 2.64 | 0.64 | 43 | 3.3 | 5.9 |
| 457 | 6 | 4 | 8 | 3 | 16 | 1688 | 124 | 99 | 29.2 | 74.4 | 7.2 | 4.84 | 3.80 | 0.60 | 48 | 5.6 | 6.6 |
| 458 | 6 | 4 | 8 | 3 | 17 | 4520 | 142 | 58 | 18.4 | 52.4 | 2.4 | 6.40 | 4.52 | 0.20 | 25 | 5.6 | 6.2 |
| 459 | 6 | 4 | 8 | 3 | 18 | 1548 | 97 | 47 | 12.0 | 88.0 | 8.0 | 2.92 | 4.04 | 1.20 | 45 | 3.8 | 5.8 |
| 460 | 6 | 4 | 8 | 3 | 19 | 2752 | 78 | 50 | 13.6 | 127.6 | 6.4 | 1.80 | 3.60 | 0.80 | 53 | 6.1 | 6.0 |
| 461 | 6 | 4 | 8 | 3 | 20 | 2308 | 60 | 38 | 13.2 | 126.0 | 7.2 | 2.28 | 3.04 | 0.68 | 52 | 5.6 | 5.8 |
| 462 | 6 | 4 | 8 | 3 | 21 | 2680 | 66 | 58 | 15.6 | 165.6 | 8.4 | 1.80 | 5.32 | 0.98 | 66 | 6.1 | 5.0 |
| 463 | 6 | 4 | 9 | 1 | 1 | 564 | 231 | 182 | 130.8 | 11.2 | 9.2 | 0.84 | 1.28 | 0.00 | 192 | 15.9 | 5.8 |
| 464 | 6 | 4 | 9 | 1 | 2 | 1521 | 164 | 31 | 18.8 | 6.8 | 6.0 | 1.48 | 1.56 | 0.02 | 78 | 5.4 | 5.8 |
| 465 | 6 | 4 | 9 | 1 | 3 | 482 | 134 | 76 | 6.0 | 5.2 | 3.2 | 2.72 | 3.32 | 0.12 | 26 | 2.6 | 5.9 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 466 | 6 | 4 | 9 | 1 | 4 | 579 | 74 | 32 | 5.2 | 4.4 | 2.4 | 2.68 | 1.52 | 0.08 | 16 | 1.6 | 5.5 |
| 467 | 6 | 4 | 9 | 1 | 5 | 700 | 89 | 27 | 6.0 | 6.4 | 3.6 | 2.80 | 1.96 | 0.08 | 28 | 2.4 | 5.9 |
| 468 | 6 | 4 | 9 | 1 | 6 | 1456 | 145 | 18 | 8.8 | 14.0 | 6.8 | 4.72 | 2.48 | 0.16 | 200 | 3.2 | 6.4 |
| 469 | 6 | 4 | 9 | 2 | 7 | 1954 | 126 | 86 | 8.8 | 10.8 | 4.0 | 3.12 | 4.88 | 0.08 | 79 | 4.3 | 6.4 |
| 470 | 6 | 4 | 9 | 2 | 8 | 1767 | 157 | 26 | 9.2 | 12.4 | 4.0 | 3.36 | 0.96 | 0.12 | 160 | 3.6 | 6.4 |
| 471 | 6 | 4 | 9 | 2 | 9 | 1210 | 131 | 45 | 8.0 | 24.8 | 12.4 | 2.96 | 0.52 | 0.12 | 492 | 3.7 | 5.5 |
| 472 | 6 | 4 | 9 | 2 | 10 | 711 | 132 | 18 | 7.6 | 5.6 | 2.0 | 1.64 | 0.64 | 0.04 | 10 | 3.0 | 5.7 |
| 473 | 6 | 4 | 9 | 2 | 11 | 1243 | 117 | 12 | 8.0 | 5.2 | 2.8 | 3.36 | 0.48 | 0.04 | 20 | 3.3 | 5.8 |
| 474 | 6 | 4 | 9 | 2 | 12 | 872 | 82 | 22 | 10.0 | 4.4 | 2.8 | 1.16 | 0.52 | 0.04 | 18 | 2.7 | 5.6 |
| 475 | 6 | 4 | 9 | 2 | 13 | 580 | 35 | 29 | 6.4 | 8.0 | 8.0 | 2.32 | 4.12 | 0.52 | 17 | 2.0 | 5.6 |
| 476 | 6 | 4 | 9 | 2 | 14 | 646 | 84 | 29 | 8.4 | 7.2 | 6.4 | 6.76 | 8.96 | 0.60 | 17 | 3.2 | 5.7 |
| 477 | 6 | 4 | 9 | 2 | 15 | 828 | 91 | 44 | 8.4 | 7.2 | 4.4 | 3.36 | 4.04 | 0.24 | 18 | 2.4 | 6.4 |
| 478 | 6 | 4 | 9 | 3 | 16 | 1999 | 63 | 34 | 10.4 | 25.2 | 3.6 | 3.76 | 3.24 | 0.44 | 29 | 4.8 | 5.7 |
| 479 | 6 | 4 | 9 | 3 | 17 | 2336 | 64 | 50 | 27.6 | 221.2 | 6.4 | 1.80 | 3.48 | 0.80 | 56 | 5.7 | 6.0 |
| 480 | 6 | 4 | 9 | 3 | 18 | 1616 | 138 | 116 | 25.2 | 162.4 | 8.4 | 6.04 | 7.72 | 1.16 | 64 | 5.8 | 6.0 |
| 481 | 6 | 4 | 9 | 3 | 19 | 1971 | 67 | 40 | 100.0 | 77.2 | 4.8 | 1.60 | 3.08 | 0.60 | 36 | 5.1 | 5.8 |
| 482 | 6 | 4 | 9 | 3 | 20 | 1104 | 52 | 52 | 13.6 | 75.6 | 10.8 | 1.80 | 6.48 | 0.64 | 56 | 10.8 | 6.0 |
| 483 | 6 | 4 | 9 | 3 | 21 | 2204 | 53 | 46 | 13.6 | 91.6 | 7.2 | 2.00 | 3.16 | 0.56 | 49 | 5.7 | 5.3 |
| 484 | 6 | 4 | 10 | 1 | 1 | 715 | 103 | 33 | 12.8 | 68.0 | 5.6 | 1.08 | 1.16 | 0.04 | 57 | 4.5 | 5.6 |
| 485 | 6 | 4 | 10 | 1 | 2 | 879 | 86 | 19 | 11.2 | 4.4 | 2.8 | 1.12 | 1.36 | 0.04 | 22 | 3.9 | 5.7 |
| 486 | 6 | 4 | 10 | 1 | 3 | 1558 | 218 | 136 | 14.0 | 8.4 | 3.2 | 3.48 | 5.20 | 0.12 | 47 | 4.3 | 5.7 |
| 487 | 6 | 4 | 10 | 1 | 4 | 1374 | 115 | 42 | 13.2 | 7.2 | 4.0 | 1.12 | 1.52 | 0.04 | 1 | 4.1 | 5.8 |
| 488 | 6 | 4 | 10 | 1 | 5 | 1355 | 120 | 25 | 10.8 | 7.6 | 4.0 | 2.24 | 2.88 | 0.08 | 28 | 2.8 | 5.6 |
| 489 | 6 | 4 | 10 | 1 | 6 | 1924 | 327 | 66 | 23.6 | 17.2 | 11.2 | 2.56 | 5.60 | 0.20 | 60 | 3.0 | 6.0 |
| 490 | 6 | 4 | 10 | 2 | 7 | 929 | 129 | 44 | 11.2 | 24.0 | 8.4 | 5.04 | 1.84 | 0.16 | 134 | 2.2 | 5.9 |
| 491 | 6 | 4 | 10 | 2 | 8 | 940 | 293 | 98 | 22.4 | 33.6 | 15.6 | 12.32 | 9.08 | 0.24 | 238 | 3.6 | 5.9 |
| 492 | 6 | 4 | 10 | 2 | 9 | 1894 | 301 | 132 | 28.8 | 38.8 | 14.8 | 12.76 | 6.68 | 0.28 | 214 | 2.5 | 5.3 |
| 493 | 6 | 4 | 10 | 2 | 10 | 1538 | 196 | 48 | 20.8 | 9.2 | 8.0 | 2.28 | 12.76 | 0.24 | 36 | 3.2 | 5.2 |
| 494 | 6 | 4 | 10 | 2 | 11 | 663 | 92 | 18 | 8.0 | 2.8 | 2.8 | 0.68 | 0.32 | 0.04 | 14 | 3.0 | 5.5 |
| 495 | 6 | 4 | 10 | 2 | 12 | 783 | 54 | 16 | 11.2 | 4.4 | 2.4 | 0.36 | 0.24 | 0.00 | 13 | 2.6 | 6.2 |
| 496 | 6 | 4 | 10 | 2 | 13 | 1150 | 109 | 50 | 6.8 | 7.6 | 2.8 | 2.84 | 5.20 | 0.40 | 13 | 3.2 | 5.8 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 497 | 6 | 4 | 10 | 2 | 14 | 1032 | 87 | 47 | 8.4 | 4.8 | 3.2 | 2.52 | 5.12 | 0.24 | 16 | 3.4 | 5.4 |
| 498 | 6 | 4 | 10 | 2 | 15 | 981 | 64 | 99 | 12.0 | 6.8 | 4.8 | 2.44 | 5.20 | 0.32 | 18 | 3.5 | 5.5 |
| 499 | 6 | 4 | 10 | 3 | 16 | 1047 | 150 | 33 | 16.8 | 5.6 | 3.2 | 1.80 | 1.28 | 0.08 | 20 | 3.2 | 5.6 |
| 500 | 6 | 4 | 10 | 3 | 17 | 1542 | 170 | 28 | 16.4 | 5.6 | 3.6 | 1.16 | 0.64 | 0.08 | 30 | 5.0 | 5.6 |
| 501 | 6 | 4 | 10 | 3 | 18 | 897 | 94 | 30 | 8.4 | 5.6 | 2.8 | 3.64 | 1.96 | 0.36 | 19 | 2.6 | 5.8 |
| 502 | 6 | 4 | 10 | 3 | 19 | 771 | 95 | 52 | 11.6 | 5.6 | 3.6 | 1.44 | 1.12 | 0.08 | 18 | 1.9 | 5.9 |
| 503 | 6 | 4 | 10 | 3 | 20 | 646 | 57 | 70 | 7.2 | 6.4 | 3.2 | 2.64 | 3.72 | 0.64 | 15 | 1.9 | 5.7 |
| 504 | 6 | 4 | 10 | 3 | 21 | 592 | 64 | 39 | 7.6 | 5.2 | 2.8 | 2.12 | 2.76 | 1.08 | 12 | 2.1 | 5.2 |
| 505 | 6 | 4 | 11 | 1 | 1 | 420 | 122 | 92 | 30.4 | 8.4 | 16.8 | 0.72 | 1.04 | 0.00 | 212 | 5.1 | 5.5 |
| 506 | 6 | 4 | 11 | 1 | 2 | 1408 | 156 | 27 | 16.0 | 6.8 | 3.2 | 1.40 | 2.36 | 0.08 | 43 | 5.3 | 6.3 |
| 507 | 6 | 4 | 11 | 1 | 3 | 1368 | 270 | 214 | 46.4 | 10.0 | 4.4 | 2.92 | 4.84 | 0.36 | 72 | 4.6 | 5.7 |
| 508 | 6 | 4 | 11 | 1 | 4 | 1569 | 232 | 69 | 10.8 | 10.8 | 4.8 | 4.64 | 3.72 | 0.16 | 41 | 3.1 | 5.9 |
| 509 | 6 | 4 | 11 | 1 | 5 | 1382 | 163 | 33 | 11.6 | 7.6 | 5.2 | 4.48 | 7.08 | 0.08 | 36 | 2.5 | 5.8 |
| 510 | 6 | 4 | 11 | 1 | 6 | 1182 | 126 | 26 | 6.4 | 5.2 | 4.0 | 2.40 | 3.16 | 0.04 | 35 | 3.5 | 6.1 |
| 511 | 6 | 4 | 11 | 2 | 7 | 1157 | 188 | 58 | 9.2 | 42.0 | 12.0 | 6.96 | 3.68 | 0.20 | 308 | 3.1 | 6.0 |
| 512 | 6 | 4 | 11 | 2 | 8 | 1172 | 110 | 14 | 7.6 | 6.4 | 3.6 | 5.28 | 1.08 | 0.04 | 82 | 2.3 | 6.2 |
| 513 | 6 | 4 | 11 | 2 | 9 | 1221 | 123 | 18 | 8.0 | 9.6 | 3.2 | 2.76 | 0.92 | 0.04 | 101 | 2.9 | 5.2 |
| 514 | 6 | 4 | 11 | 2 | 10 | 853 | 90 | 18 | 7.6 | 8.0 | 3.2 | 2.08 | 2.20 | 0.08 | 18 | 3.4 | 5.4 |
| 515 | 6 | 4 | 11 | 2 | 11 | 757 | 96 | 19 | 8.8 | 7.6 | 4.0 | 2.08 | 2.00 | 0.08 | 15 | 3.6 | 5.3 |
| 516 | 6 | 4 | 11 | 2 | 12 | 775 | 98 | 26 | 11.2 | 8.4 | 4.4 | 1.84 | 1.56 | 0.12 | 19 | 4.0 | 5.6 |
| 517 | 6 | 4 | 11 | 2 | 13 | 954 | 83 | 40 | 18.8 | 11.6 | 8.0 | 4.20 | 5.80 | 0.88 | 20 | 2.9 | 5.5 |
| 518 | 6 | 4 | 11 | 2 | 14 | 1397 | 159 | 108 | 35.2 | 17.2 | 32.4 | 7.60 | 17.60 | 1.36 | 28 | 3.3 | 5.3 |
| 519 | 6 | 4 | 11 | 2 | 15 | 1631 | 195 | 161 | 48.8 | 20.0 | 25.6 | 6.44 | 11.64 | 1.12 | 46 | 3.0 | 5.6 |
| 520 | 6 | 4 | 11 | 3 | 16 | 1496 | 224 | 58 | 29.2 | 8.8 | 4.8 | 2.84 | 2.80 | 0.44 | 29 | 3.6 | 6.3 |
| 521 | 6 | 4 | 11 | 3 | 17 | 1862 | 181 | 85 | 32.4 | 32.0 | 23.6 | 3.44 | 2.60 | 0.72 | 238 | 2.1 | 5.7 |
| 522 | 6 | 4 | 11 | 3 | 18 | 1644 | 202 | 77 | 21.2 | 35.6 | 8.0 | 5.04 | 12.36 | 0.60 | 242 | 2.6 | 5.7 |
| 523 | 6 | 4 | 11 | 3 | 19 | 1217 | 161 | 114 | 23.6 | 5.2 | 2.8 | 1.36 | 1.88 | 0.32 | 34 | 3.8 | 6.1 |
| 524 | 6 | 4 | 11 | 3 | 20 | 1422 | 145 | 56 | 12.8 | 5.2 | 2.4 | 1.56 | 1.84 | 0.20 | 54 | 1.4 | 5.7 |
| 525 | 6 | 4 | 11 | 3 | 21 | 1232 | 250 | 54 | 53.6 | 7.2 | 6.4 | 1.36 | 2.68 | 0.52 | 92 | 5.0 | 5.0 |
| 526 | 6 | 4 | 12 | 1 | 1 | 670 | 246 | 246 | 133.6 | 14.4 | 13.6 | 1.32 | 2.04 | 0.28 | 546 | 3.1 | 5.7 |
| 527 | 6 | 4 | 12 | 1 | 2 | 1282 | 126 | 60 | 37.2 | 7.6 | 4.8 | 5.12 | 3.68 | 1.00 | 28 | 2.5 | 5.8 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | AL | OM | PH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 528 | 6 | 4 | 12 | 1 | 3 | 1043 | 115 | 82 | 23.2 | 9.2 | 5.6 | 3.64 | 5.56 | 2.28 | 24 | 1.8 | 6.0 |
| 529 | 6 | 4 | 12 | 1 | 4 | 1035 | 92 | 109 | 25.6 | 11.2 | 5.6 | 4.64 | 5.88 | 1.36 | 26 | 1.7 | 5.9 |
| 530 | 6 | 4 | 12 | 1 | 5 | 638 | 76 | 46 | 14.8 | 4.0 | 3.2 | 1.08 | 1.12 | 0.28 | 17 | 3.1 | 5.6 |
| 531 | 6 | 4 | 12 | 1 | 6 | 1282 | 149 | 31 | 20.0 | 4.8 | 3.2 | 1.04 | 0.92 | 0.16 | 27 | 4.2 | 6.2 |
| 532 | 6 | 4 | 12 | 2 | 7 | 940 | 145 | 37 | 21.2 | 27.6 | 11.6 | 4.00 | 2.00 | 0.32 | 268 | 2.3 | 6.2 |
| 533 | 6 | 4 | 12 | 2 | 8 | 1004 | 368 | 88 | 36.4 | 14.4 | 4.8 | 8.24 | 3.72 | 0.44 | 141 | 2.4 | 6.2 |
| 534 | 6 | 4 | 12 | 2 | 9 | 1970 | 316 | 76 | 32.0 | 18.0 | 6.8 | 7.96 | 5.36 | 0.52 | 208 | 3.8 | 5.4 |
| 535 | 6 | 4 | 12 | 2 | 10 | 564 | 105 | 20 | 10.0 | 4.4 | 4.8 | 1.16 | 6.28 | 0.16 | 24 | 2.7 | 5.4 |
| 536 | 6 | 4 | 12 | 2 | 11 | 1126 | 165 | 32 | 22.4 | 5.2 | 4.8 | 1.16 | 0.96 | 0.28 | 26 | 2.8 | 5.7 |
| 537 | 6 | 4 | 12 | 2 | 12 | 752 | 46 | 12 | 9.6 | 3.2 | 2.4 | 0.28 | 0.40 | 0.20 | 15 | 2.9 | 6.3 |
| 538 | 6 | 4 | 12 | 2 | 13 | 998 | 94 | 47 | 6.8 | 6.4 | 2.8 | 2.32 | 4.36 | 0.36 | 13 | 2.1 | 6.0 |
| 539 | 6 | 4 | 12 | 2 | 14 | 1044 | 85 | 51 | 16.8 | 4.8 | 3.2 | 2.24 | 4.32 | 0.36 | 17 | 3.0 | 5.7 |
| 540 | 6 | 4 | 12 | 2 | 15 | 1426 | 91 | 138 | 40.8 | 10.8 | 7.2 | 3.80 | 8.16 | 0.84 | 30 | 2.7 | 5.7 |
| 541 | 6 | 4 | 12 | 3 | 16 | 826 | 121 | 32 | 22.8 | 4.4 | 2.8 | 1.52 | 1.48 | 0.24 | 18 | 3.1 | 5.8 |
| 542 | 6 | 4 | 12 | 3 | 17 | 1168 | 132 | 29 | 17.6 | 4.0 | 3.6 | 0.92 | 0.88 | 0.24 | 26 | 4.0 | 5.9 |
| 543 | 6 | 4 | 12 | 3 | 18 | 730 | 84 | 50 | 15.2 | 4.4 | 3.6 | 1.16 | 1.28 | 0.16 | 20 | 3.1 | 5.9 |
| 544 | 6 | 4 | 12 | 3 | 19 | 1148 | 109 | 121 | 16.4 | 15.2 | 7.2 | 5.60 | 6.40 | 1.68 | 31 | 1.6 | 5.7 |
| 545 | 6 | 4 | 12 | 3 | 20 | 568 | 63 | 39 | 6.4 | 4.8 | 2.8 | 2.00 | 2.96 | 1.04 | 13 | 2.0 | 5.7 |
| 546 | 6 | 4 | 12 | 3 | 21 | 781 | 77 | 27 | 13.2 | 4.8 | 2.8 | 3.12 | 1.80 | 0.48 | 18 | 2.5 | 4.7 |

# FORAGE DATA CODES

OBS = Observation number (1-544).

SAM = Sample type.

YR = yrar (2-4).

MTH = Month (1-12).

TR = Treatment (1-3).

OB = Sample observation (1-21).

Macrominerals (Dry matter basis)

CA = Calcium, %.

K = Potassium, %.

MG = Magnesium, %.

NA = Sodium, %.

P = Phosphorus, %.

CP = Crude protein, %.

IVOMD = In vitro organic matter digestibility, %.

Microminerals (Dry matter basis)

FE = Iron, ppm.

CO = Cobalt, ppm.

Cu = Copper, ppm.

MN = Manganese, ppm.

MO = Molybdenum, ppm.

SE = Selenium, ppm.

ZN = Zinc, ppm.

FORAGE DATA

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | CO | MO | SE | CP | IVOMD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5 | 2 | 5 | 1 | 1 | 0.35 | 0.29 | 0.83 | 0.021 | 0.14 | 46.9 | 63 | 26.5 | 6.42 | 0.066 | 0.211 | 0.048 | 8.50 | 51.7 |
| 2 | 5 | 2 | 5 | 1 | 2 | 0.38 | 0.22 | 0.69 | 0.030 | 0.16 | 42.3 | 100 | 50.3 | 3.69 | 0.078 | 0.325 | 0.078 | 8.51 | 50.7 |
| 3 | 5 | 2 | 5 | 1 | 3 | 0.37 | 0.24 | 0.88 | 0.034 | 0.13 | 52.6 | 103 | 25.2 | 4.56 | 0.066 | 0.261 | 0.064 | 9.66 | 48.0 |
| 4 | 5 | 2 | 5 | 1 | 4 | 0.46 | 0.19 | 0.68 | 0.078 | 0.08 | 38.3 | 38 | 15.5 | 2.18 | 0.043 | 0.128 | 0.027 | 8.53 | 54.6 |
| 5 | 5 | 2 | 5 | 1 | 5 | 0.41 | 0.18 | 0.89 | 0.029 | 0.05 | 43.6 | 60 | 14.7 | 1.74 | 0.048 | 0.196 | 0.109 | 5.53 | 38.6 |
| 6 | 5 | 2 | 5 | 1 | 6 | 0.27 | 0.10 | 0.02 | 0.184 | . | 39.7 | 39 | 9.3 | 1.36 | 0.035 | 0.091 | . | . | . |
| 7 | 5 | 2 | 5 | 2 | 7 | 0.56 | 0.18 | 0.88 | 0.038 | . | 39.4 | 64 | 15.8 | 1.91 | 0.062 | 0.946 | . | . | . |
| 8 | 5 | 2 | 5 | 2 | 8 | 0.52 | 0.20 | 0.87 | 0.020 | 0.17 | 46.1 | 82 | 16.5 | 2.44 | 0.065 | 0.564 | 0.071 | 9.00 | 53.4 |
| 9 | 5 | 2 | 5 | 2 | 9 | 0.55 | 0.17 | 0.91 | 0.027 | . | 34.5 | 48 | 13.5 | 1.04 | 0.049 | 0.695 | . | . | . |
| 10 | 5 | 2 | 5 | 2 | 10 | 0.65 | 0.17 | 0.80 | 0.022 | 0.14 | 41.5 | 39 | 15.4 | 1.81 | 0.033 | 0.798 | 0.027 | 7.96 | 52.4 |
| 11 | 5 | 2 | 5 | 2 | 11 | 0.42 | 0.15 | 0.56 | 0.038 | 0.15 | 42.2 | 43 | 9.1 | 1.55 | 0.038 | 0.342 | 0.052 | 7.05 | 49.2 |
| 12 | 5 | 2 | 5 | 2 | 12 | 0.41 | 0.14 | 1.08 | 0.026 | . | 39.9 | 79 | 13.3 | 1.47 | 0.032 | 0.399 | . | . | . |
| 13 | 5 | 2 | 5 | 2 | 13 | 0.61 | 0.16 | 0.92 | 0.036 | 0.13 | 38.8 | 37 | 16.0 | 3.56 | 0.050 | 0.587 | 0.045 | 7.76 | 51.4 |
| 14 | 5 | 2 | 5 | 2 | 14 | 0.54 | 0.18 | 1.13 | 0.041 | 0.13 | 43.9 | 43 | 13.1 | 2.58 | 0.046 | 0.253 | 0.034 | 10.11 | 55.5 |
| 15 | 5 | 2 | 5 | 2 | 15 | 0.52 | 0.18 | 1.00 | 0.034 | . | 46.7 | 25 | 14.6 | 2.34 | 0.037 | 0.478 | . | . | . |
| 16 | 5 | 2 | 5 | 3 | 16 | 0.46 | 0.12 | 0.97 | 0.022 | 0.15 | 38.0 | 23 | 12.9 | 3.98 | 0.039 | 0.238 | 0.054 | 7.26 | 44.9 |
| 17 | 5 | 2 | 5 | 3 | 17 | 0.54 | 0.12 | 0.51 | 0.022 | 0.15 | 48.6 | 35 | 12.1 | 1.13 | 0.053 | 0.216 | 0.104 | 7.02 | 43.0 |
| 18 | 5 | 2 | 5 | 3 | 18 | 0.54 | 0.11 | 0.47 | 0.019 | . | 49.6 | 12 | 12.6 | 1.78 | 0.050 | 0.446 | . | . | . |
| 19 | 5 | 2 | 5 | 3 | 19 | 0.55 | 0.12 | 1.41 | 0.022 | 0.15 | 41.8 | 36 | 21.1 | 5.14 | 0.032 | 0.550 | 0.088 | 9.56 | 54.2 |
| 20 | 5 | 2 | 5 | 3 | 20 | 0.50 | 0.17 | 1.17 | 0.016 | 0.11 | 42.9 | 37 | 24.8 | 4.72 | 0.041 | 0.509 | 0.110 | 8.66 | 51.9 |
| 21 | 5 | 2 | 5 | 3 | 21 | 0.48 | 0.19 | 1.31 | 0.024 | 0.14 | 37.6 | 10 | 18.9 | 4.12 | 0.035 | 0.634 | 0.084 | 8.92 | 50.4 |
| 22 | 5 | 2 | 11 | 1 | 1 | 0.36 | 0.28 | 0.71 | 0.016 | 0.19 | 30.5 | 67 | 17.8 | 3.73 | 0.059 | 0.231 | 0.129 | 8.63 | 37.8 |
| 23 | 5 | 2 | 11 | 1 | 2 | 0.40 | 0.31 | 0.35 | 0.025 | 0.11 | 37.4 | 20 | 10.9 | 4.22 | 0.037 | 0.337 | 0.078 | 6.58 | 38.2 |
| 24 | 5 | 2 | 11 | 1 | 3 | 0.45 | 0.25 | 0.39 | 0.041 | 0.07 | 30.6 | 51 | 13.5 | 2.67 | 0.026 | 0.156 | 0.041 | 7.98 | 41.2 |
| 25 | 5 | 2 | 11 | 1 | 4 | 0.37 | 0.28 | 0.39 | 0.029 | 0.07 | 34.2 | 20 | 15.1 | 1.98 | 0.030 | 0.048 | 0.065 | 7.60 | 39.2 |
| 26 | 5 | 2 | 11 | 1 | 5 | 0.42 | 0.26 | 0.40 | 0.042 | . | 37.8 | 22 | 11.3 | 2.33 | 0.044 | 0.259 | . | . | . |
| 27 | 5 | 2 | 11 | 1 | 6 | 0.44 | 0.24 | 0.36 | 0.030 | 0.08 | 60.5 | 15 | 10.5 | 2.27 | 0.042 | 0.238 | 0.034 | 7.38 | 42.5 |
| 28 | 5 | 2 | 11 | 2 | 7 | 0.35 | 0.25 | 0.84 | 0.021 | . | 39.9 | 80 | 27.9 | 6.38 | 0.076 | 0.558 | . | . | . |
| 29 | 5 | 2 | 11 | 2 | 8 | 0.47 | 0.28 | 0.93 | 0.014 | 0.18 | 52.5 | 126 | 27.9 | 11.15 | 0.084 | 0.300 | 0.108 | 8.92 | 37.4 |
| 30 | 5 | 2 | 11 | 2 | 9 | 0.45 | 0.22 | 0.87 | 0.023 | . | 51.6 | 105 | 27.9 | 4.10 | 0.109 | 0.149 | . | . | . |
| 31 | 5 | 2 | 11 | 2 | 10 | 0.44 | 0.25 | 0.40 | 0.012 | 0.10 | 26.0 | 113 | 17.8 | 4.27 | 0.028 | 0.116 | 0.048 | 7.81 | 44.2 |
| 32 | 5 | 2 | 11 | 2 | 11 | 0.29 | 0.31 | 0.41 | 0.011 | 0.19 | 28.1 | 111 | 11.4 | 4.95 | 0.037 | 0.337 | 0.052 | 10.18 | 41.2 |
| 33 | 5 | 2 | 11 | 2 | 12 | 0.46 | 0.27 | 0.56 | 0.014 | 0.16 | 36.1 | 70 | 16.0 | 5.79 | 0.030 | 0.410 | 0.055 | 7.69 | 35.3 |
| 34 | 5 | 2 | 11 | 2 | 13 | 0.43 | 0.24 | 0.73 | 0.016 | . | 37.5 | 56 | 17.1 | 7.02 | 0.030 | 0.291 | . | . | . |
| 35 | 5 | 2 | 11 | 2 | 14 | 0.49 | 0.22 | 0.69 | 0.020 | 0.06 | 35.3 | 105 | 23.0 | 6.68 | 0.036 | 0.309 | 0.070 | 6.45 | 37.4 |
| 36 | 5 | 2 | 11 | 2 | 15 | 0.34 | 0.28 | 0.71 | 0.014 | 0.19 | 33.5 | 49 | 14.6 | 3.46 | 0.052 | 0.324 | 0.075 | 8.43 | 37.5 |
| 37 | 5 | 2 | 11 | 3 | 16 | 0.45 | 0.33 | 0.44 | 0.023 | 0.08 | 34.8 | 18 | 11.6 | 2.75 | 0.033 | 0.148 | 0.052 | 6.90 | 39.9 |
| 38 | 5 | 2 | 11 | 3 | 17 | 0.40 | 0.35 | 0.39 | 0.024 | 0.10 | 31.2 | 9 | 11.6 | 2.34 | 0.037 | 0.473 | 0.045 | 7.25 | 38.0 |
| 39 | 5 | 2 | 11 | 3 | 18 | 0.43 | 0.38 | 0.58 | 0.059 | . | 36.1 | 7 | 12.5 | 2.23 | 0.035 | 0.638 | . | . | . |
| 40 | 5 | 2 | 11 | 3 | 19 | 0.43 | 0.28 | 0.69 | 0.033 | 0.11 | 36.5 | 29 | 15.7 | 2.70 | 0.036 | 0.349 | 0.102 | 8.69 | 42.7 |
| 41 | 5 | 2 | 11 | 3 | 20 | 0.43 | 0.29 | 0.82 | 0.022 | 0.16 | 41.0 | 56 | 22.8 | 6.55 | 0.057 | 0.234 | 0.104 | 9.97 | 42.6 |
| 42 | 5 | 2 | 11 | 3 | 21 | 0.47 | 0.26 | 0.53 | 0.037 | . | 32.7 | 17 | 12.3 | 4.29 | 0.040 | 0.268 | . | . | . |
| 43 | 5 | 3 | 1 | 1 | 1 | 0.30 | 0.15 | 0.53 | 0.021 | 0.18 | 32.8 | 122 | 40.8 | 2.22 | 0.068 | 1.089 | 0.057 | 7.53 | 25.4 |
| 44 | 5 | 3 | 1 | 1 | 2 | 0.42 | 0.21 | 0.34 | 0.015 | 0.16 | 48.9 | 49 | 17.8 | 2.55 | 0.164 | 1.471 | 0.055 | 7.41 | 31.1 |
| 45 | 5 | 3 | 1 | 1 | 3 | 0.37 | 0.21 | 0.37 | 0.028 | 0.12 | 36.9 | 47 | 12.8 | 1.63 | 0.094 | 1.187 | 0.062 | 6.00 | 36.2 |
| 46 | 5 | 3 | 1 | 1 | 4 | 0.36 | 0.19 | 0.37 | 0.018 | 0.10 | 44.4 | 44 | 12.8 | 1.87 | 0.055 | 1.884 | 0.064 | 6.93 | 39.6 |
| 47 | 5 | 3 | 1 | 1 | 5 | 0.29 | 0.18 | 0.53 | 0.015 | 0.11 | 40.6 | 43 | 14.6 | 1.85 | 0.045 | 1.608 | 0.097 | 7.17 | 41.1 |
| 48 | 5 | 3 | 1 | 1 | 6 | 0.38 | 0.18 | 0.36 | 0.018 | . | 44.7 | 30 | 13.8 | 1.97 | 0.065 | 0.958 | . | . | . |
| 49 | 5 | 3 | 1 | 2 | 7 | 0.26 | 0.08 | 0.76 | 0.129 | . | 56.1 | 67 | 15.1 | 4.25 | 0.080 | 0.666 | . | . | . |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | CO | MO | SE | CP | IVOMD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | 5 | 3 | 1 | 2 | 8 | 0.16 | 0.09 | 0.80 | 0.229 | . | 53.1 | 30 | 6.9 | 1.22 | 0.060 | 4.482 | . | . | . |
| 51 | 5 | 3 | 1 | 2 | 9 | 0.39 | 0.14 | 0.27 | 0.091 | 0.08 | 70.2 | 35 | 17.5 | 1.98 | 0.050 | 1.404 | 0.097 | 7.59 | 27.2 |
| 52 | 5 | 3 | 1 | 2 | 10 | 0.35 | 0.22 | 0.22 | 0.020 | 0.07 | 38.0 | 42 | 9.0 | 2.16 | 0.070 | 1.541 | 0.104 | 6.07 | 34.6 |
| 53 | 5 | 3 | 1 | 2 | 11 | 0.14 | 0.10 | 0.43 | 0.096 | . | 32.6 | 53 | 9.4 | 1.17 | 0.046 | 2.023 | . | . | . |
| 54 | 5 | 3 | 1 | 2 | 12 | 0.29 | 0.09 | 0.63 | 0.077 | 0.15 | 51.7 | 39 | 30.9 | 2.38 | 0.074 | 1.509 | 0.044 | 5.64 | 34.1 |
| 55 | 5 | 3 | 1 | 2 | 13 | 0.59 | 0.18 | 0.18 | 0.009 | . | 47.3 | 50 | 19.1 | 3.23 | 0.048 | 0.538 | . | . | . |
| 56 | 5 | 3 | 1 | 2 | 14 | 0.52 | 0.17 | 0.38 | 0.020 | 0.14 | 49.0 | 40 | 19.9 | 2.50 | 0.048 | 1.127 | 0.221 | 6.86 | 27.0 |
| 57 | 5 | 3 | 1 | 2 | 15 | 0.64 | 0.19 | 0.28 | 0.015 | 0.14 | 71.1 | 35 | 19.8 | 2.55 | 0.076 | 1.437 | 0.083 | 7.31 | 34.1 |
| 58 | 5 | 3 | 1 | 3 | 16 | 0.56 | 0.12 | 0.33 | 0.039 | 0.14 | 44.3 | 71 | 30.4 | 2.08 | 0.047 | 0.939 | 0.055 | 7.09 | 34.1 |
| 59 | 5 | 3 | 1 | 3 | 17 | 0.51 | 0.15 | 0.42 | 0.022 | 0.13 | 55.9 | 40 | 15.8 | 1.68 | 0.048 | 0.876 | 0.077 | 7.32 | 34.2 |
| 60 | 5 | 3 | 1 | 3 | 18 | 0.54 | 0.11 | 0.36 | 0.043 | 0.11 | 49.1 | 20 | 23.8 | 3.58 | 0.048 | 0.629 | 0.117 | 8.00 | 33.7 |
| 61 | 5 | 3 | 1 | 3 | 19 | 0.46 | 0.23 | 0.32 | 0.027 | 0.10 | 69.5 | 61 | 18.9 | 4.03 | 0.084 | 1.732 | 0.111 | 6.04 | 36.4 |
| 62 | 5 | 3 | 1 | 3 | 20 | 0.39 | 0.24 | 0.28 | 0.013 | 0.11 | 43.7 | 46 | 22.0 | 4.27 | 0.048 | 1.427 | 0.069 | 8.01 | 27.6 |
| 63 | 5 | 3 | 1 | 3 | 21 | 0.45 | 0.18 | 0.30 | 0.030 | . | 51.1 | 32 | 19.8 | 3.82 | 0.053 | 1.180 | . | . | . |
| 64 | 5 | 3 | 2 | 1 | 1 | 0.38 | 0.25 | 0.12 | 0.015 | 0.09 | 33.1 | 144 | 17.7 | 2.50 | 0.027 | 0.700 | 0.064 | 5.57 | 30.9 |
| 65 | 5 | 3 | 2 | 1 | 2 | 0.34 | 0.26 | 0.32 | 0.010 | 0.11 | 22.7 | 38 | 15.1 | 2.44 | 0.048 | 1.125 | 0.076 | 7.09 | 29.0 |
| 66 | 5 | 3 | 2 | 1 | 3 | 0.35 | 0.23 | 0.34 | 0.019 | 0.14 | 26.5 | 94 | 21.9 | 3.36 | 0.053 | 1.362 | 0.076 | 8.26 | 26.3 |
| 67 | 5 | 3 | 2 | 1 | 4 | 0.40 | 0.20 | 0.09 | 0.009 | 0.07 | 24.5 | 29 | 12.3 | 1.97 | 0.032 | 1.192 | 0.051 | 5.04 | 33.0 |
| 68 | 5 | 3 | 2 | 1 | 5 | 0.36 | 0.21 | 0.31 | 0.011 | 0.09 | 80.2 | 141 | 15.1 | 2.60 | 0.030 | 1.672 | 0.090 | 7.18 | 34.3 |
| 69 | 5 | 3 | 2 | 1 | 6 | 0.33 | 0.17 | 0.23 | 0.007 | . | 29.1 | 83 | 15.3 | 2.96 | 0.030 | 0.671 | . | . | . |
| 70 | 5 | 3 | 2 | 2 | 7 | 0.43 | 0.16 | 0.38 | 0.014 | 0.13 | 39.4 | 58 | 21.7 | 3.99 | 0.033 | 1.142 | 0.046 | 6.84 | 31.8 |
| 71 | 5 | 3 | 2 | 2 | 8 | 0.44 | 0.17 | 0.24 | 0.014 | 0.18 | 34.2 | 23 | 19.0 | 3.63 | 0.033 | 1.699 | 0.062 | 9.03 | 36.6 |
| 72 | 5 | 3 | 2 | 2 | 9 | 0.36 | 0.15 | 0.29 | 0.020 | . | 27.2 | 56 | 16.0 | 2.93 | 0.035 | 4.538 | . | . | . |
| 73 | 5 | 3 | 2 | 2 | 10 | 0.36 | 0.25 | 0.11 | 0.017 | 0.13 | 32.6 | 153 | 18.0 | 2.56 | 0.035 | 0.464 | 0.109 | 5.64 | 35.7 |
| 74 | 5 | 3 | 2 | 2 | 11 | 0.39 | 0.20 | 0.12 | 0.015 | 0.09 | 29.9 | 103 | 10.3 | 2.16 | 0.032 | 0.771 | 0.069 | 5.96 | 35.6 |
| 75 | 5 | 3 | 2 | 2 | 12 | 0.35 | 0.24 | 0.18 | 0.013 | . | 24.6 | 135 | 15.7 | 2.35 | 0.084 | 0.317 | . | . | . |
| 76 | 5 | 3 | 2 | 2 | 13 | 0.49 | 0.17 | 0.28 | 0.009 | . | 30.8 | 69 | 24.8 | 2.69 | 0.048 | 0.572 | . | . | . |
| 77 | 5 | 3 | 2 | 2 | 14 | 0.45 | 0.18 | 0.22 | 0.010 | 0.12 | 27.2 | 59 | 20.0 | 2.56 | 0.048 | 1.889 | 0.069 | 7.99 | 35.5 |
| 78 | 5 | 3 | 2 | 2 | 15 | 0.46 | 0.18 | 0.16 | 0.009 | . | 28.6 | 100 | 41.5 | 2.26 | 0.050 | 0.405 | . | . | . |
| 79 | 5 | 3 | 2 | 3 | 16 | 0.56 | 0.15 | 0.25 | 0.007 | 0.14 | 88.3 | 17 | 65.7 | 3.42 | 0.048 | 4.900 | 0.109 | 6.94 | 33.5 |
| 80 | 5 | 3 | 2 | 3 | 17 | 0.57 | 0.15 | 0.16 | 0.008 | 0.16 | 42.0 | 21 | 14.5 | 2.57 | 0.032 | 1.223 | 0.145 | 8.88 | 34.4 |
| 81 | 5 | 3 | 2 | 3 | 18 | 0.48 | 0.15 | 0.15 | 0.008 | 0.16 | 51.5 | 38 | 21.2 | 3.72 | 0.027 | 1.159 | 0.117 | 9.00 | 36.1 |
| 82 | 5 | 3 | 2 | 3 | 19 | 0.55 | 0.19 | 0.10 | 0.007 | 0.07 | 24.9 | 38 | 23.6 | 2.59 | 0.064 | 1.822 | 0.109 | 5.24 | 35.8 |
| 83 | 5 | 3 | 2 | 3 | 20 | 0.52 | 0.21 | 0.11 | 0.007 | 0.08 | 31.4 | 50 | 19.9 | 2.61 | 0.060 | 0.905 | 0.145 | 7.50 | 37.4 |
| 84 | 5 | 3 | 2 | 3 | 21 | 0.45 | 0.15 | 0.17 | 0.004 | . | 32.6 | 29 | 16.1 | 2.30 | 0.061 | 0.112 | . | . | . |
| 85 | 5 | 3 | 3 | 1 | 1 | 0.40 | 0.16 | 0.41 | 0.015 | 0.12 | 65.2 | 58 | 19.3 | 2.21 | 0.030 | 1.098 | 0.080 | 7.24 | 39.4 |
| 86 | 5 | 3 | 3 | 1 | 2 | 0.44 | 0.16 | 0.36 | 0.013 | 0.13 | 54.8 | 44 | 13.9 | 2.27 | 0.082 | 1.960 | 0.069 | 8.33 | 41.1 |
| 87 | 5 | 3 | 3 | 1 | 3 | 0.37 | 0.20 | 0.40 | 0.014 | 0.16 | 56.3 | 119 | 35.4 | 3.04 | 0.047 | 2.103 | 0.090 | 10.08 | 37.4 |
| 88 | 5 | 3 | 3 | 1 | 4 | 0.30 | 0.14 | 0.29 | 0.019 | 0.15 | 49.7 | 52 | 9.3 | 1.88 | 0.061 | 1.141 | 0.086 | 9.24 | 33.2 |
| 89 | 5 | 3 | 3 | 1 | 5 | 0.32 | 0.16 | 0.57 | 0.065 | 0.15 | 53.3 | 55 | 74.0 | 2.84 | 0.048 | 1.143 | 0.110 | 11.89 | 54.2 |
| 90 | 5 | 3 | 3 | 1 | 6 | 0.43 | 0.18 | 0.49 | 0.035 | . | 56.2 | 63 | 14.4 | 2.39 | 0.045 | 1.131 | . | . | . |
| 91 | 5 | 3 | 3 | 2 | 7 | 0.35 | 0.16 | 0.27 | 0.010 | 0.12 | 60.2 | 52 | 45.9 | 2.31 | 0.034 | 1.958 | 0.063 | 6.95 | 36.1 |
| 92 | 5 | 3 | 3 | 2 | 8 | 0.33 | 0.15 | 0.24 | 0.015 | 0.09 | 65.5 | 52 | 16.3 | 2.15 | 0.056 | 1.075 | 0.082 | 6.31 | 390.0 |
| 93 | 5 | 3 | 3 | 2 | 9 | 0.38 | 0.16 | 0.41 | 0.012 | . | 50.6 | 45 | 26.8 | 2.17 | 0.058 | 1.162 | . | . | . |
| 94 | 5 | 3 | 3 | 2 | 10 | 0.50 | 0.20 | 0.49 | 0.013 | 0.18 | 72.9 | 241 | 39.3 | 4.11 | 0.205 | 0.924 | 0.143 | 8.29 | 39.2 |
| 95 | 5 | 3 | 3 | 2 | 11 | 0.46 | 0.16 | 0.43 | 0.014 | 0.22 | 67.2 | 144 | 40.1 | 3.31 | 0.158 | 1.085 | 0.124 | 8.70 | 43.6 |
| 96 | 5 | 3 | 3 | 2 | 12 | 0.40 | 0.18 | 0.47 | 0.014 | . | 62.1 | 169 | 48.1 | 4.23 | 0.137 | 0.835 | . | . | . |
| 97 | 5 | 3 | 3 | 2 | 13 | 0.50 | 0.19 | 0.32 | 0.016 | . | 65.0 | 213 | 24.2 | 3.15 | 0.028 | 0.925 | . | . | . |
| 98 | 5 | 3 | 3 | 2 | 14 | 0.38 | 0.18 | 0.26 | 0.011 | 0.13 | 52.1 | 194 | 19.8 | 2.38 | 0.095 | 2.337 | 0.103 | 8.61 | 40.4 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | CO | MO | SE | CP | IVOMD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 99 | 5 | 3 | 3 | 2 | 15 | 0.34 | 0.18 | 0.35 | 0.011 | . | 53.5 | 122 | 14.9 | 2.55 | 0.027 | 0.518 | . | . | . |
| 100 | 5 | 3 | 3 | 3 | 16 | 0.52 | 0.15 | 0.52 | 0.014 | 0.16 | 90.2 | 18 | 33.1 | 2.77 | 0.061 | 0.272 | 0.120 | 9.19 | 42.0 |
| 101 | 5 | 3 | 3 | 3 | 17 | 0.52 | 0.20 | 0.66 | 0.030 | 0.22 | 77.1 | 61 | 18.5 | 3.06 | 0.047 | 1.444 | 0.103 | 10.79 | 48.5 |
| 102 | 5 | 3 | 3 | 3 | 18 | 0.44 | 0.16 | 0.48 | 0.014 | 0.19 | 63.5 | 123 | 25.9 | 2.94 | 0.060 | 1.432 | 0.055 | 9.80 | 45.3 |
| 103 | 5 | 3 | 3 | 3 | 19 | 0.60 | 0.15 | 0.48 | 0.020 | 0.20 | 66.1 | 68 | 36.3 | 4.72 | 0.091 | 1.926 | 0.098 | 13.08 | 49.6 |
| 104 | 5 | 3 | 3 | 3 | 20 | 0.46 | 0.16 | 0.79 | 0.018 | 0.21 | 79.7 | 74 | 30.7 | 4.46 | 0.036 | 1.826 | 0.090 | 15.47 | 53.6 |
| 105 | 5 | 3 | 3 | 3 | 21 | 0.49 | 0.17 | 0.68 | 0.017 | . | 52.0 | 63 | 23.5 | 2.57 | 0.128 | 0.938 | . | . | . |
| 106 | 5 | 3 | 4 | 1 | 1 | 0.41 | 0.19 | 0.62 | 0.019 | 0.21 | 46.7 | 84 | 17.0 | 2.20 | 0.054 | 0.319 | 0.103 | 9.76 | 50.9 |
| 107 | 5 | 3 | 4 | 1 | 2 | 0.38 | 0.19 | 1.04 | 0.019 | 0.22 | 60.9 | 68 | 28.6 | 4.28 | 0.040 | 0.551 | 0.049 | 13.44 | 56.5 |
| 108 | 5 | 3 | 4 | 1 | 3 | 0.40 | 0.18 | 0.72 | 0.017 | 0.23 | 49.4 | 133 | 26.6 | 2.42 | 0.098 | 0.736 | 0.070 | 11.06 | 51.0 |
| 109 | 5 | 3 | 4 | 1 | 4 | 0.29 | 0.22 | 0.57 | 0.015 | 0.20 | 45.6 | 40 | 16.6 | 2.17 | 0.054 | 0.407 | 0.069 | 9.54 | 48.6 |
| 110 | 5 | 3 | 4 | 1 | 5 | 0.17 | 0.10 | 0.19 | 0.008 | 0.14 | 27.6 | 24 | 8.3 | 8.30 | 0.049 | 0.022 | 0.049 | 8.72 | 44.8 |
| 111 | 5 | 3 | 4 | 1 | 6 | 0.34 | 0.21 | 0.91 | 0.031 | . | 52.4 | 19 | 13.9 | 1.81 | 0.044 | 0.621 | . | . | . |
| 112 | 5 | 3 | 4 | 2 | 7 | 0.44 | 0.18 | 1.09 | 0.021 | . | 58.0 | 105 | 19.4 | 2.63 | 0.057 | 0.547 | . | . | . |
| 113 | 5 | 3 | 4 | 2 | 8 | 0.33 | 0.19 | 0.73 | 0.014 | 0.21 | 46.3 | 76 | 17.6 | 1.69 | 0.060 | 0.767 | 0.057 | 9.47 | 41.3 |
| 114 | 5 | 3 | 4 | 2 | 9 | 0.58 | 0.22 | 0.57 | 0.097 | 0.16 | 66.5 | 56 | 18.4 | 2.94 | 0.082 | 1.092 | 0.042 | 9.82 | 53.3 |
| 115 | 5 | 3 | 4 | 2 | 10 | 0.32 | 0.10 | 0.33 | 0.044 | . | 46.3 | 22 | 7.4 | 2.07 | 0.054 | 0.120 | . | . | 5.0 |
| 116 | 5 | 3 | 4 | 2 | 12 | 0.42 | 0.16 | 0.39 | 0.031 | . | 54.1 | 122 | 18.4 | 2.54 | 0.064 | 0.282 | . | . | . |
| 117 | 5 | 3 | 4 | 2 | 13 | 0.37 | 0.21 | 0.71 | 0.020 | 0.20 | 56.7 | 120 | 36.7 | 4.12 | 0.051 | 0.037 | 0.046 | 10.05 | 51.6 |
| 118 | 5 | 3 | 4 | 2 | 14 | 0.35 | 0.18 | 0.78 | 0.012 | 0.22 | 60.1 | 0 | 42.1 | 3.20 | 0.047 | 0.420 | 0.042 | 10.68 | 52.4 |
| 119 | 5 | 3 | 4 | 2 | 15 | 0.36 | 0.15 | 0.98 | 0.015 | . | 67.0 | 114 | 54.1 | 2.71 | 0.044 | 0.061 | . | . | . |
| 120 | 5 | 3 | 4 | 3 | 16 | 0.24 | 0.08 | 0.34 | 0.007 | 0.17 | 35.5 | 39 | 10.3 | 1.48 | 0.074 | 0.098 | 0.069 | 7.71 | 41.8 |
| 121 | 5 | 3 | 4 | 3 | 17 | 0.31 | 0.10 | 0.35 | 0.010 | 0.20 | 46.0 | 52 | 13.1 | 1.99 | 0.060 | 0.039 | 0.112 | 8.83 | 43.5 |
| 122 | 5 | 3 | 4 | 3 | 18 | 0.47 | 0.17 | 0.61 | 0.016 | 0.23 | 69.4 | 52 | 18.7 | 3.64 | 0.055 | 0.364 | 0.077 | 10.40 | 44.4 |
| 123 | 5 | 3 | 4 | 3 | 19 | 0.26 | 0.13 | 0.15 | 0.007 | 0.15 | 38.2 | 25 | 23.5 | 1.68 | 0.065 | 0.522 | 0.092 | 7.39 | 40.4 |
| 124 | 5 | 3 | 4 | 3 | 20 | 0.41 | 0.11 | 0.30 | 0.010 | 0.11 | 44.7 | 20 | 17.7 | 2.07 | 0.059 | 0.022 | 0.105 | 9.76 | 42.7 |
| 125 | 5 | 3 | 4 | 3 | 21 | 0.50 | 0.18 | 0.59 | 0.013 | . | 56.1 | 31 | 22.6 | 2.66 | 0.053 | 0.702 | . | . | . |
| 126 | 5 | 3 | 5 | 1 | 1 | 0.41 | 0.15 | 0.86 | 0.036 | 0.16 | 41.8 | 28 | 15.8 | 1.70 | 0.024 | 0.655 | 0.103 | 9.80 | 49.9 |
| 127 | 5 | 3 | 5 | 1 | 2 | 0.38 | 0.25 | 1.17 | 0.022 | 0.26 | 48.8 | 84 | 26.2 | 2.49 | 0.105 | 0.596 | 0.056 | 12.27 | 54.6 |
| 128 | 5 | 3 | 5 | 1 | 3 | 0.40 | 0.27 | 0.77 | 0.029 | 0.19 | 39.5 | 45 | 13.4 | 2.84 | 0.024 | 1.097 | 0.028 | 10.93 | 51.7 |
| 129 | 5 | 3 | 5 | 1 | 4 | 0.37 | 0.19 | 0.66 | 0.047 | 0.12 | 39.9 | 40 | 9.8 | 1.52 | 0.026 | 0.509 | 0.057 | 9.20 | 45.1 |
| 130 | 5 | 3 | 5 | 1 | 5 | 0.30 | 0.22 | 0.75 | 0.043 | 0.17 | 44.7 | 40 | 6.9 | 1.27 | 0.019 | 0.711 | 0.042 | 11.10 | 50.5 |
| 131 | 5 | 3 | 5 | 1 | 6 | 0.25 | 0.22 | 0.97 | 0.031 | . | 61.7 | 36 | 9.7 | 1.96 | 0.027 | 0.561 | . | . | . |
| 132 | 5 | 3 | 5 | 2 | 7 | 0.56 | 0.23 | 0.67 | 0.032 | . | 46.0 | 53 | 17.4 | 3.45 | 0.036 | 0.959 | . | . | . |
| 133 | 5 | 3 | 5 | 2 | 8 | 0.45 | 0.22 | 0.84 | 0.028 | 0.22 | 71.5 | 55 | 18.0 | 2.04 | 0.026 | 1.043 | 0.035 | 8.90 | 46.5 |
| 134 | 5 | 3 | 5 | 2 | 9 | 0.38 | 0.23 | 1.02 | 0.023 | . | 50.0 | 72 | 20.6 | 0.86 | 0.057 | 0.989 | . | . | . |
| 135 | 5 | 3 | 5 | 2 | 10 | 0.49 | 0.23 | 1.94 | 0.028 | 0.36 | 58.7 | 135 | 41.7 | 8.34 | 0.111 | 0.384 | 0.040 | 16.64 | 54.2 |
| 136 | 5 | 3 | 5 | 2 | 11 | 0.42 | 0.23 | 1.81 | 0.028 | 0.36 | 49.3 | 96 | 35.7 | 6.93 | 0.089 | 0.325 | 0.035 | 15.50 | 56.8 |
| 137 | 5 | 3 | 5 | 2 | 12 | 0.41 | 0.26 | 1.59 | 0.029 | . | 47.9 | 96 | 33.2 | 6.19 | 0.078 | 0.414 | . | . | . |
| 138 | 5 | 3 | 5 | 2 | 13 | 0.52 | 0.18 | 0.81 | 0.021 | 0.15 | 46.1 | 90 | 13.3 | 3.58 | 0.042 | 0.824 | 0.029 | 10.01 | 51.2 |
| 139 | 5 | 3 | 5 | 2 | 14 | 0.56 | 0.21 | 0.43 | 0.039 | 0.13 | 38.7 | 45 | 11.2 | 3.87 | 0.064 | 0.458 | 0.049 | 8.40 | 47.3 |
| 140 | 5 | 3 | 5 | 2 | 15 | 0.34 | 0.17 | 1.12 | 0.050 | . | 36.3 | 42 | 10.6 | 3.26 | 0.038 | 0.187 | . | . | . |
| 141 | 5 | 3 | 5 | 3 | 16 | 0.54 | 0.12 | 1.19 | 0.028 | 0.26 | 41.8 | 29 | 22.4 | 3.44 | 0.019 | 0.631 | 0.029 | 12.77 | 53.4 |
| 142 | 5 | 3 | 5 | 3 | 17 | 0.57 | 0.27 | 0.81 | 0.029 | 0.28 | 40.4 | 44 | 21.9 | 3.63 | 0.014 | 0.424 | 0.042 | 12.70 | 55.5 |
| 143 | 5 | 3 | 5 | 3 | 18 | 0.42 | 0.19 | 1.31 | 0.029 | 0.28 | 40.4 | 46 | 22.1 | 4.76 | 0.019 | 0.443 | 0.042 | 12.51 | 55.3 |
| 144 | 5 | 3 | 5 | 3 | 19 | 0.49 | 0.27 | 1.09 | 0.032 | 0.27 | 50.0 | 66 | 28.7 | 5.00 | 0.017 | 0.333 | 0.052 | 16.40 | 61.1 |
| 145 | 5 | 3 | 5 | 3 | 20 | 0.51 | 0.26 | 0.88 | 0.025 | 0.20 | 65.3 | 36 | 23.4 | 4.37 | 0.015 | 0.254 | 0.049 | 11.90 | 55.1 |
| 146 | 5 | 3 | 5 | 3 | 21 | 0.49 | 0.24 | 1.46 | 0.045 | . | 72.0 | 87 | 31.1 | 3.55 | 0.665 | 0.194 | . | . | . |
| 147 | 5 | 3 | 6 | 1 | 1 | 0.25 | 0.22 | 1.05 | 0.035 | 0.16 | 41.9 | 47 | 25.6 | 2.01 | 0.039 | 0.794 | 0.069 | 8.18 | 50.2 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | CO | MO | SE | CP | IVOMD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 148 | 5 | 3 | 6 | 1 | 2 | 0.38 | 0.20 | 0.95 | 0.014 | 0.21 | 41.7 | 26 | 17.6 | 4.00 | 0.039 | 0.799 | 0.099 | 8.65 | 53.1 |
| 149 | 5 | 3 | 6 | 1 | 3 | 0.37 | 0.28 | 1.06 | 0.018 | 0.22 | 37.0 | 27 | 19.8 | 4.26 | 0.023 | 0.796 | 0.021 | 9.06 | 51.1 |
| 150 | 5 | 3 | 6 | 1 | 4 | 0.28 | 0.19 | 1.26 | 0.049 | 0.16 | 36.5 | 36 | 14.7 | 1.33 | 0.022 | 0.465 | 0.017 | 8.69 | 55.4 |
| 151 | 5 | 3 | 6 | 1 | 5 | 0.32 | 0.17 | 1.10 | 0.031 | 0.15 | 41.9 | 35 | 17.1 | 3.13 | 0.047 | 0.754 | 0.021 | 9.25 | 55.9 |
| 152 | 5 | 3 | 6 | 1 | 6 | 0.32 | 0.16 | 1.19 | 0.024 | . | 38.0 | 57 | 15.8 | 3.60 | 0.036 | 0.353 | . | . | . |
| 153 | 5 | 3 | 6 | 2 | 7 | 0.63 | 0.35 | 1.71 | 0.069 | . | 70.4 | 66 | 40.2 | 2.07 | 0.027 | 1.196 | . | . | . |
| 154 | 5 | 3 | 6 | 2 | 8 | 0.40 | 0.17 | 0.94 | 0.017 | 0.22 | 37.6 | 17 | 20.1 | 2.25 | 0.039 | 0.899 | 0.035 | 9.45 | 52.6 |
| 155 | 5 | 3 | 6 | 2 | 9 | 0.44 | 0.16 | 0.92 | 0.042 | . | 34.1 | 18 | 19.9 | 2.81 | 0.039 | 0.529 | . | . | . |
| 156 | 5 | 3 | 6 | 2 | 10 | 0.43 | 0.21 | 0.84 | 0.029 | 0.15 | 29.5 | 56 | 13.4 | 3.15 | 0.026 | 1.188 | 0.029 | 6.99 | 53.7 |
| 157 | 5 | 3 | 6 | 2 | 11 | 0.42 | 0.19 | 0.86 | 0.020 | 0.16 | 29.4 | 71 | 12.9 | 3.00 | 0.035 | 0.680 | 0.028 | 11.00 | 55.2 |
| 158 | 5 | 3 | 6 | 2 | 12 | 0.38 | 0.21 | 0.72 | 0.017 | . | 31.9 | 68 | 18.6 | 3.58 | 0.059 | 0.839 | . | . | . |
| 159 | 5 | 3 | 6 | 2 | 13 | 0.39 | 0.35 | 1.14 | 0.031 | 0.17 | 36.2 | 47 | 25.0 | 4.05 | 0.025 | 0.146 | 0.028 | 9.39 | 51.0 |
| 160 | 5 | 3 | 6 | 2 | 14 | 0.34 | 0.36 | 1.31 | 0.032 | 0.11 | 41.2 | 43 | 26.5 | 4.56 | 0.021 | 0.110 | 0.021 | 7.02 | 51.2 |
| 161 | 5 | 3 | 6 | 2 | 15 | 0.31 | 0.16 | 1.43 | 0.038 | . | 36.5 | 41 | 28.4 | 4.36 | 0.020 | 0.027 | . | . | . |
| 162 | 5 | 3 | 6 | 3 | 16 | 0.39 | 0.18 | 1.09 | 0.023 | 0.26 | 33.0 | 32 | 16.3 | 3.16 | 0.026 | 0.837 | 0.023 | 8.18 | 49.9 |
| 163 | 5 | 3 | 6 | 3 | 17 | 0.49 | 0.16 | 0.92 | 0.023 | 0.24 | 40.6 | 25 | 22.9 | 3.85 | 0.021 | 0.997 | 0.035 | 10.19 | 53.7 |
| 164 | 5 | 3 | 6 | 3 | 18 | 0.43 | 0.15 | 0.86 | 0.025 | 0.20 | 36.4 | 49 | 14.3 | 3.47 | 0.036 | 0.610 | 0.084 | 8.58 | 53.1 |
| 165 | 5 | 3 | 6 | 3 | 19 | 0.51 | 0.24 | 0.76 | 0.022 | 0.13 | 44.0 | 21 | 19.8 | 4.00 | 0.034 | 0.688 | 0.046 | 9.87 | 56.0 |
| 166 | 5 | 3 | 6 | 3 | 20 | 0.40 | 0.21 | 0.89 | 0.013 | 0.11 | 32.5 | 30 | 24.0 | 4.57 | 0.018 | 0.970 | 0.063 | 8.72 | 52.6 |
| 167 | 5 | 3 | 6 | 3 | 21 | 0.43 | 0.18 | 0.95 | 0.025 | . | 36.1 | 31 | 32.3 | 4.00 | 0.026 | 0.666 | . | . | . |
| 168 | 5 | 3 | 7 | 1 | 1 | 0.33 | 0.29 | 0.78 | 0.030 | 0.31 | 56.6 | 70 | 23.5 | 2.33 | 0.023 | 0.715 | 0.036 | 12.45 | 55.9 |
| 169 | 5 | 3 | 7 | 1 | 2 | 0.30 | 0.33 | 1.24 | 0.034 | 0.07 | 59.6 | 26 | 12.8 | 2.77 | 0.013 | 1.244 | 0.056 | 7.90 | 25.6 |
| 170 | 5 | 3 | 7 | 1 | 3 | 0.27 | 0.27 | 1.00 | 0.025 | 0.26 | 45.1 | 39 | 18.6 | 2.03 | 0.020 | 0.836 | 0.209 | 10.44 | 51.2 |
| 171 | 5 | 3 | 7 | 1 | 4 | 0.34 | 0.21 | 0.44 | 0.085 | 0.09 | 43.4 | 26 | 12.0 | 2.82 | 0.032 | 1.312 | 0.042 | 8.52 | 49.6 |
| 172 | 5 | 3 | 7 | 1 | 5 | 0.14 | 0.08 | 0.28 | 0.095 | 0.15 | 36.4 | 18 | 7.5 | 1.96 | 0.022 | 0.044 | 0.132 | 10.34 | 50.0 |
| 173 | 5 | 3 | 7 | 1 | 6 | 0.32 | 0.17 | 0.56 | 0.067 | . | 36.5 | 31 | 8.6 | 1.46 | 0.020 | 0.657 | . | . | . |
| 174 | 5 | 3 | 7 | 2 | 7 | 0.40 | 0.25 | 0.82 | 0.023 | . | 43.1 | 39 | 22.3 | 2.75 | 0.018 | 0.835 | . | . | . |
| 175 | 5 | 3 | 7 | 2 | 8 | 0.29 | 0.19 | 1.30 | 0.025 | 0.25 | 43.8 | 59 | 26.4 | 3.87 | 0.038 | 0.608 | 0.076 | 10.75 | 53.3 |
| 176 | 5 | 3 | 7 | 2 | 9 | 0.37 | 0.28 | 0.88 | 0.021 | . | 51.4 | 50 | 17.9 | 2.68 | 0.019 | 0.407 | . | . | . |
| 177 | 5 | 3 | 7 | 2 | 10 | 0.40 | 0.28 | 0.39 | 0.034 | 0.25 | 44.3 | 31 | 7.7 | 2.32 | 0.040 | 0.416 | 0.042 | 9.89 | 48.7 |
| 178 | 5 | 3 | 7 | 2 | 11 | 0.43 | 0.37 | 0.45 | 0.038 | 0.11 | 48.1 | 55 | 14.2 | 2.60 | 0.021 | 1.006 | 0.021 | 7.97 | 49.6 |
| 179 | 5 | 3 | 7 | 2 | 12 | 0.45 | 0.34 | 0.69 | 0.026 | . | 43.0 | 61 | 13.2 | 2.40 | 0.055 | 0.764 | . | . | . |
| 180 | 5 | 3 | 7 | 2 | 13 | 0.36 | 0.20 | 0.79 | 0.033 | 0.09 | 38.2 | 74 | 26.3 | 1.64 | 0.062 | 0.414 | 0.030 | 6.93 | 44.0 |
| 181 | 5 | 3 | 7 | 2 | 14 | 0.26 | 0.20 | 0.52 | 0.119 | 0.24 | 49.1 | 35 | 10.2 | 1.73 | 0.017 | 0.045 | 0.021 | 7.94 | 45.8 |
| 182 | 5 | 3 | 7 | 2 | 15 | 0.29 | 0.18 | 0.84 | 0.041 | . | 39.4 | 64 | 24.9 | 3.14 | 0.052 | 0.027 | . | . | . |
| 183 | 5 | 3 | 7 | 3 | 16 | 0.37 | 0.22 | 0.98 | 0.018 | 0.24 | 45.0 | 27 | 16.2 | 1.65 | 0.035 | 0.571 | 0.030 | 7.39 | 50.6 |
| 184 | 5 | 3 | 7 | 3 | 17 | 0.30 | 0.21 | 1.13 | 0.021 | 0.26 | 42.6 | 32 | 23.7 | 3.34 | 0.023 | 0.302 | 0.014 | 6.69 | 51.8 |
| 185 | 5 | 3 | 7 | 3 | 18 | 0.24 | 0.16 | 1.22 | 0.022 | 0.15 | 40.4 | 28 | 20.6 | 4.70 | 0.016 | 0.317 | 0.028 | 6.58 | 49.2 |
| 186 | 5 | 3 | 7 | 3 | 19 | 0.47 | 0.33 | 0.40 | 0.018 | 0.15 | 42.5 | 35 | 70.6 | 3.92 | 0.020 | 0.757 | 0.089 | 7.70 | 50.2 |
| 187 | 5 | 3 | 7 | 3 | 20 | 0.35 | 0.23 | 0.99 | 0.033 | 0.17 | 41.0 | 61 | 25.4 | 3.55 | 0.023 | 0.109 | 0.049 | 7.87 | 50.5 |
| 188 | 5 | 3 | 7 | 3 | 21 | 0.32 | 0.15 | 0.82 | 0.029 | . | 40.4 | 16 | 22.8 | 3.49 | 0.021 | 0.377 | . | . | . |
| 189 | 5 | 3 | 8 | 1 | 1 | 0.30 | 0.29 | 1.01 | 0.055 | 0.21 | 43.6 | 62 | 19.3 | 2.24 | 0.064 | 0.529 | 0.036 | 8.63 | 49.3 |
| 190 | 5 | 3 | 8 | 1 | 2 | 0.32 | 0.36 | 0.76 | 0.037 | 0.17 | 37.0 | 27 | 13.0 | 3.22 | 0.022 | 0.751 | 0.062 | 6.60 | 48.2 |
| 191 | 5 | 3 | 8 | 1 | 3 | 0.28 | 0.24 | 1.04 | 0.038 | 0.21 | 33.0 | 14 | 16.2 | 7.68 | 0.005 | 0.903 | 0.028 | 8.23 | 50.9 |
| 192 | 5 | 3 | 8 | 1 | 4 | 0.35 | 0.29 | 0.91 | 0.026 | 0.10 | 41.3 | 36 | 13.2 | 2.86 | 0.039 | 0.209 | 0.024 | 6.16 | 44.3 |
| 193 | 5 | 3 | 8 | 1 | 5 | 0.36 | 0.37 | 0.52 | 0.020 | 0.09 | 40.8 | 28 | 15.4 | 3.65 | 0.003 | 0.585 | 0.028 | 7.31 | 50.1 |
| 194 | 5 | 3 | 8 | 1 | 6 | 0.34 | 0.28 | 0.61 | 0.049 | . | 33.2 | 30 | 9.8 | 2.25 | 0.021 | 0.112 | . | . | . |
| 195 | 5 | 3 | 8 | 2 | 7 | 0.38 | 0.31 | 1.10 | 0.029 | 0.18 | 51.2 | 16 | 13.8 | 2.06 | 0.016 | 0.629 | 0.048 | 7.93 | 46.2 |
| 196 | 5 | 3 | 8 | 2 | 8 | 0.37 | 0.40 | 1.17 | 0.037 | 0.22 | 53.7 | 19 | 14.5 | 2.30 | 0.002 | 1.008 | 0.084 | 9.23 | 49.5 |

| OBS | SAM | YR | MTH | TR | 08 | CA | MG | K | NA | P | FE | MN | ZN | CU | CO | MO | SE | CP | IVOMD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 197 | 5 | 3 | 8 | 2 | 9 | 0.30 | 0.28 | 1.02 | 0.026 | . | 44.0 | 24 | 11.2 | 1.81 | 0.021 | 1.025 | . | . | . |
| 198 | 5 | 3 | 8 | 2 | 10 | 0.30 | 0.29 | 0.43 | 0.055 | 0.09 | 38.7 | 40 | 10.0 | 5.81 | 0.012 | 0.307 | 0.030 | 6.20 | 41.2 |
| 199 | 5 | 3 | 8 | 2 | 11 | 0.34 | 0.26 | 0.60 | 0.026 | 0.10 | 42.3 | 21 | 6.5 | 5.73 | 0.027 | 0.552 | 0.049 | 6.13 | 40.6 |
| 200 | 5 | 3 | 8 | 2 | 12 | 0.38 | 0.46 | 0.65 | 0.040 | . | 43.2 | 66 | 13.4 | 4.75 | 0.038 | 0.647 | . | . | . |
| 201 | 5 | 3 | 8 | 2 | 13 | 0.36 | 0.26 | 0.92 | 0.030 | . | 34.7 | 84 | 17.9 | 2.06 | 0.073 | 0.559 | . | . | . |
| 202 | 5 | 3 | 8 | 2 | 14 | 0.31 | 0.19 | 1.54 | 0.029 | 0.18 | 33.0 | 43 | 20.3 | 4.30 | 0.014 | 0.198 | 0.049 | 7.79 | 46.6 |
| 203 | 5 | 3 | 8 | 2 | 15 | 0.48 | 0.30 | 0.79 | 0.016 | . | 36.0 | 58 | 16.9 | 2.20 | 0.036 | 0.532 | . | . | . |
| 204 | 5 | 3 | 8 | 3 | 16 | 0.37 | 0.23 | 0.72 | 0.028 | 0.21 | 46.5 | 7 | 9.7 | 1.42 | 0.010 | 0.657 | 0.035 | 6.94 | 46.8 |
| 205 | 5 | 3 | 8 | 3 | 17 | 0.42 | 0.29 | 0.90 | 0.021 | 0.23 | 40.9 | 42 | 15.7 | 2.42 | 0.005 | 0.339 | 0.062 | 7.09 | 45.6 |
| 206 | 5 | 3 | 8 | 3 | 18 | 0.33 | 0.22 | 0.98 | 0.039 | 0.21 | 31.4 | 38 | 14.7 | 2.42 | 0.007 | 0.347 | 0.053 | 6.80 | 44.4 |
| 207 | 5 | 3 | 8 | 3 | 19 | 0.42 | 0.31 | 0.69 | 0.016 | 0.12 | 40.6 | 29 | 15.6 | 1.41 | 0.036 | 0.546 | 0.047 | 7.72 | 44.9 |
| 208 | 5 | 3 | 8 | 3 | 20 | 0.57 | 0.20 | 0.86 | 0.026 | 0.16 | 37.5 | 23 | 16.8 | 1.88 | 0.002 | 0.440 | 0.056 | 7.14 | 45.6 |
| 209 | 5 | 3 | 8 | 3 | 21 | 0.49 | 0.18 | 0.59 | 0.014 | . | 48.5 | 22 | 18.0 | 1.53 | 0.039 | 0.770 | . | . | . |
| 210 | 5 | 3 | 9 | 1 | 1 | 0.32 | 0.22 | 0.82 | 0.037 | 0.13 | 37.7 | 24 | 9.7 | 2.24 | 0.045 | 0.984 | 0.065 | 7.43 | 41.2 |
| 211 | 5 | 3 | 9 | 1 | 2 | 0.32 | 0.25 | 0.91 | 0.016 | 0.24 | 29.9 | 44 | 18.2 | 2.12 | 0.033 | 0.619 | 0.014 | 7.99 | 52.0 |
| 212 | 5 | 3 | 9 | 1 | 3 | 0.33 | 0.24 | 1.48 | 0.015 | 0.31 | 47.8 | 74 | 42.0 | 5.32 | 0.098 | 0.790 | 0.035 | 14.63 | 61.9 |
| 213 | 5 | 3 | 9 | 1 | 4 | 0.25 | 0.19 | 0.87 | 0.020 | 0.10 | 32.2 | 34 | 8.9 | 2.03 | 0.033 | 0.379 | 0.072 | 7.15 | 46.6 |
| 214 | 5 | 3 | 9 | 1 | 5 | 0.25 | 0.17 | 1.25 | 0.032 | 0.13 | 35.1 | 21 | 28.4 | 2.30 | 0.047 | 0.351 | 0.077 | 8.81 | 49.1 |
| 215 | 5 | 3 | 9 | 1 | 6 | 0.22 | 0.21 | 1.40 | 0.014 | . | 52.8 | 24 | 39.2 | 3.15 | 0.031 | 0.293 | . | . | . |
| 216 | 5 | 3 | 9 | 2 | 7 | 0.39 | 0.34 | 0.70 | 0.020 | . | 43.1 | 18 | 12.7 | 3.68 | 0.030 | 0.588 | . | . | . |
| 217 | 5 | 3 | 9 | 2 | 8 | 0.33 | 0.29 | 0.83 | 0.024 | 0.20 | 42.8 | 38 | 11.8 | 4.71 | 0.039 | 0.567 | 0.063 | 9.77 | 43.2 |
| 218 | 5 | 3 | 9 | 2 | 9 | 0.33 | 0.18 | 0.89 | 0.037 | . | 49.0 | 43 | 19.5 | 3.90 | 0.049 | 1.191 | . | . | . |
| 219 | 5 | 3 | 9 | 2 | 10 | 0.32 | 0.28 | 1.28 | 0.014 | 0.27 | 33.3 | 84 | 28.5 | 3.08 | 0.112 | 0.973 | 0.071 | 9.13 | 45.2 |
| 220 | 5 | 3 | 9 | 2 | 11 | 0.37 | 0.26 | 1.23 | 0.022 | 0.28 | 31.0 | 83 | 24.7 | 2.83 | 0.088 | 0.576 | 0.041 | 10.49 | 45.6 |
| 221 | 5 | 3 | 9 | 2 | 12 | 0.34 | 0.28 | 1.15 | 0.012 | . | 31.4 | 102 | 30.7 | 2.55 | 0.080 | 0.707 | . | . | . |
| 222 | 5 | 3 | 9 | 2 | 13 | 0.43 | 0.16 | 0.73 | 0.042 | 0.16 | 40.2 | 30 | 10.1 | 3.15 | 0.064 | 0.538 | 0.042 | 8.43 | 45.6 |
| 223 | 5 | 3 | 9 | 2 | 14 | 0.32 | 0.19 | 0.78 | 0.018 | 0.16 | 34.7 | 72 | 8.6 | 2.07 | 0.123 | 0.114 | 0.069 | 7.44 | 47.5 |
| 224 | 5 | 3 | 9 | 2 | 15 | 0.30 | 0.17 | 0.80 | 0.015 | . | 32.8 | 64 | 14.9 | 1.79 | 0.106 | 0.214 | . | . | . |
| 225 | 5 | 3 | 9 | 3 | 16 | 0.51 | 0.29 | 0.52 | 0.009 | 0.17 | 42.1 | 3 | 12.4 | 2.49 | 0.030 | 1.043 | 0.042 | 7.07 | 40.0 |
| 226 | 5 | 3 | 9 | 3 | 17 | 0.37 | 0.21 | 0.95 | 0.011 | 0.19 | 30.7 | 24 | 17.4 | 2.28 | 0.042 | 0.649 | 0.014 | 8.76 | 43.9 |
| 227 | 5 | 3 | 9 | 3 | 18 | 0.31 | 0.19 | 1.09 | 0.020 | 0.18 | 32.3 | 30 | 19.0 | 2.98 | 0.039 | 0.974 | 0.021 | 7.92 | 47.5 |
| 228 | 5 | 3 | 9 | 3 | 19 | 0.31 | 0.26 | 0.90 | 0.020 | 0.12 | 46.6 | 48 | 18.9 | 3.06 | 0.036 | 0.958 | 0.042 | 10.05 | 46.7 |
| 229 | 5 | 3 | 9 | 3 | 20 | 0.32 | 0.19 | 1.22 | 0.013 | 0.13 | 33.0 | 23 | 17.8 | 2.84 | 0.032 | 0.918 | 0.032 | 8.29 | 51.3 |
| 230 | 5 | 3 | 9 | 3 | 21 | 0.39 | 0.18 | 1.30 | 0.022 | . | 34.5 | 19 | 23.6 | 4.94 | 0.031 | 0.715 | . | . | . |
| 231 | 5 | 3 | 10 | 1 | 1 | 0.26 | 0.14 | 0.26 | 0.032 | 0.12 | 32.0 | 14 | 7.8 | 1.03 | 0.036 | 1.175 | 0.072 | 9.12 | 39.7 |
| 232 | 5 | 3 | 10 | 1 | 2 | 0.31 | 0.23 | 0.31 | 0.029 | 0.16 | 26.2 | 44 | 8.9 | 1.87 | 0.028 | 0.574 | 0.067 | 7.80 | 41.0 |
| 233 | 5 | 3 | 10 | 1 | 3 | 0.28 | 0.24 | 0.60 | 0.036 | 0.21 | 27.7 | 44 | 9.1 | 2.62 | 0.040 | 0.459 | 0.077 | 8.23 | 39.5 |
| 234 | 5 | 3 | 10 | 1 | 4 | 0.24 | 0.15 | 0.49 | 0.036 | 0.13 | 25.4 | 43 | 6.8 | 1.77 | 0.031 | 0.435 | 0.054 | 6.48 | 37.1 |
| 235 | 5 | 3 | 10 | 1 | 5 | 0.29 | 0.20 | 0.35 | 0.033 | 0.15 | 26.7 | 52 | 5.9 | 1.31 | 0.033 | 0.141 | 0.077 | 7.01 | 40.1 |
| 236 | 5 | 3 | 10 | 1 | 6 | 0.19 | 0.13 | 0.21 | 0.024 | . | 21.4 | 17 | 1.3 | 1.29 | 0.020 | 0.492 | . | . | . |
| 237 | 5 | 3 | 10 | 2 | 7 | 0.35 | 0.18 | 0.77 | 0.038 | . | 54.3 | 27 | 11.3 | 3.42 | 0.026 | 0.894 | . | . | . |
| 238 | 5 | 3 | 10 | 2 | 8 | 0.25 | 0.17 | 1.14 | 0.034 | 0.22 | 43.1 | 35 | 19.4 | 2.59 | 0.016 | 0.706 | 0.038 | 10.12 | 41.8 |
| 239 | 5 | 3 | 10 | 2 | 9 | 0.33 | 0.15 | 0.61 | 0.037 | . | 30.1 | 9 | 11.5 | 1.53 | 0.025 | 0.607 | . | . | . |
| 240 | 5 | 3 | 10 | 2 | 10 | 0.32 | 0.21 | 0.68 | 0.038 | 0.21 | 40.2 | 73 | 18.0 | 2.68 | 0.072 | 0.492 | 0.048 | 9.44 | 37.2 |
| 241 | 5 | 3 | 10 | 2 | 11 | 0.34 | 0.20 | 0.40 | 0.041 | 0.16 | 31.3 | 67 | 9.5 | 2.64 | 0.047 | 0.451 | 0.077 | 6.60 | 39.2 |
| 242 | 5 | 3 | 10 | 2 | 12 | 0.39 | 0.25 | 0.45 | 0.064 | . | 37.0 | 141 | 13.3 | 3.28 | 0.113 | 0.693 | . | . | . |
| 243 | 5 | 3 | 10 | 2 | 13 | 0.33 | 0.21 | 0.75 | 0.040 | 0.23 | 31.3 | 85 | 19.6 | 2.72 | 0.077 | 0.684 | 0.048 | 11.02 | 37.8 |
| 244 | 5 | 3 | 10 | 2 | 14 | 0.35 | 0.20 | 0.30 | 0.035 | 0.17 | 20.5 | 74 | 9.2 | 4.50 | 0.065 | 0.373 | 0.029 | 6.87 | 40.7 |
| 245 | 5 | 3 | 10 | 2 | 15 | 0.30 | 0.20 | 0.55 | 0.045 | . | 37.3 | 60 | 11.3 | 1.97 | 0.044 | 0.437 | . | . | . |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | CO | MO | SE | CP | IVOMD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 246 | 5 | 3 | 10 | 3 | 16 | 0.27 | 0.14 | 0.42 | 0.033 | 0.18 | 30.3 | 14 | 11.5 | 2.07 | 0.027 | 0.824 | 0.125 | 7.87 | 37.6 |
| 247 | 5 | 3 | 10 | 3 | 17 | 0.42 | 0.21 | 0.56 | 0.037 | 0.21 | 33.8 | 37 | 17.0 | 3.18 | 0.042 | 0.484 | 0.077 | 8.45 | 35.5 |
| 248 | 5 | 3 | 10 | 3 | 18 | 0.29 | 0.17 | 0.53 | 0.034 | 0.19 | 28.7 | 35 | 8.2 | 1.69 | 0.025 | 0.506 | 0.054 | 8.79 | 38.3 |
| 249 | 5 | 3 | 10 | 3 | 19 | 0.45 | 0.32 | 0.41 | 0.041 | 0.21 | 27.8 | 54 | 11.6 | 2.83 | 0.030 | 0.551 | 0.054 | 9.88 | 51.2 |
| 250 | 5 | 3 | 10 | 3 | 20 | 0.44 | 0.27 | 0.50 | 0.047 | 0.15 | 32.2 | 63 | 11.9 | 3.91 | 0.023 | 0.616 | 0.145 | 8.52 | 54.4 |
| 251 | 5 | 3 | 10 | 3 | 21 | 0.49 | 0.24 | 0.75 | 0.034 | . | 41.5 | 37 | 21.8 | 4.26 | 0.036 | 0.664 | . | . | . |
| 252 | 5 | 3 | 11 | 1 | 1 | 0.33 | 0.21 | 0.48 | 0.032 | 0.16 | 35.7 | 70 | 14.2 | 2.14 | 0.037 | 1.098 | 0.083 | 7.13 | 35.7 |
| 253 | 5 | 3 | 11 | 1 | 2 | 0.36 | 0.22 | 0.35 | 0.022 | 0.16 | 37.0 | 52 | 10.1 | 1.99 | 0.020 | 0.654 | 0.087 | 6.68 | 39.2 |
| 254 | 5 | 3 | 11 | 1 | 3 | 0.26 | 0.22 | 0.52 | 0.041 | 0.17 | 29.6 | 43 | 14.3 | 4.03 | 0.033 | 0.575 | 0.125 | 7.30 | 39.4 |
| 255 | 5 | 3 | 11 | 1 | 4 | 0.29 | 0.15 | 0.34 | 0.028 | 0.10 | 29.2 | 56 | 7.3 | 2.25 | 0.031 | 0.559 | 0.072 | 5.47 | 38.1 |
| 256 | 5 | 3 | 11 | 1 | 5 | 0.23 | 0.17 | 0.45 | 0.027 | 0.08 | 34.0 | 34 | 6.6 | 2.77 | 0.046 | 0.399 | 0.125 | 6.21 | 38.4 |
| 257 | 5 | 3 | 11 | 1 | 6 | 0.32 | 0.18 | 0.44 | 0.022 | . | 39.6 | 54 | 8.6 | 1.61 | 0.043 | 0.616 | . | . | . |
| 258 | 5 | 3 | 11 | 2 | 7 | 0.35 | 0.23 | 0.85 | 0.043 | . | 44.8 | 44 | 15.7 | 8.74 | 0.024 | 1.907 | . | . | . |
| 259 | 5 | 3 | 11 | 2 | 8 | 0.33 | 0.21 | 0.77 | 0.037 | 0.22 | 45.4 | 39 | 12.7 | 1.86 | 0.030 | 1.614 | 0.077 | 10.79 | 53.4 |
| 260 | 5 | 3 | 11 | 2 | 9 | 0.32 | 0.21 | 0.95 | 0.043 | . | 40.6 | 39 | 15.1 | 2.56 | 0.027 | 1.538 | . | . | . |
| 261 | 5 | 3 | 11 | 2 | 10 | 0.37 | 0.21 | 0.34 | 0.038 | 0.13 | 35.8 | 58 | 7.7 | 2.80 | 0.023 | 1.075 | 0.065 | 7.10 | 39.4 |
| 262 | 5 | 3 | 11 | 2 | 11 | 0.33 | 0.20 | 0.34 | 0.025 | 0.13 | 32.4 | 84 | 8.9 | 1.84 | 0.039 | 0.664 | 0.211 | 6.47 | 35.4 |
| 263 | 5 | 3 | 11 | 2 | 12 | 0.32 | 0.24 | 0.34 | 0.039 | . | 34.3 | 97 | 9.3 | 3.59 | 0.057 | 0.574 | . | . | . |
| 264 | 5 | 3 | 11 | 2 | 13 | 0.32 | 0.16 | 0.92 | 0.028 | 0.26 | 37.7 | 85 | 19.5 | 1.13 | 0.053 | 0.706 | 0.054 | 12.22 | 48.4 |
| 265 | 5 | 3 | 11 | 2 | 14 | 0.30 | 0.20 | 0.60 | 0.026 | 0.20 | 32.1 | 87 | 37.4 | 2.23 | 0.039 | 0.926 | 0.077 | 8.65 | 42.5 |
| 266 | 5 | 3 | 11 | 2 | 15 | 0.30 | 0.19 | 0.90 | 0.039 | . | 34.5 | 63 | 18.7 | 1.78 | 0.045 | 0.578 | . | . | . |
| 267 | 5 | 3 | 11 | 3 | 16 | 0.36 | 0.17 | 0.56 | 0.050 | 0.20 | 40.9 | 13 | 12.9 | 4.09 | 0.031 | 0.752 | 0.053 | 9.07 | 37.9 |
| 268 | 5 | 3 | 11 | 3 | 17 | 0.39 | 0.19 | 0.58 | 0.036 | 0.17 | 48.1 | 64 | 12.6 | 3.26 | 0.035 | 1.027 | 0.039 | 7.10 | 44.4 |
| 269 | 5 | 3 | 11 | 3 | 18 | 0.31 | 0.19 | 0.45 | 0.028 | 0.18 | 39.5 | 44 | 16.4 | 3.73 | 0.044 | 0.579 | 0.096 | 7.54 | 39.3 |
| 270 | 5 | 3 | 11 | 3 | 19 | 0.33 | 0.24 | 0.40 | 0.024 | 0.10 | 31.9 | 76 | 13.5 | 2.38 | 0.034 | 0.578 | 0.089 | 7.35 | 46.8 |
| 271 | 5 | 3 | 11 | 3 | 20 | 0.44 | 0.23 | 0.42 | 0.026 | 0.09 | 32.8 | 37 | 15.8 | 3.12 | 0.044 | 0.662 | 0.058 | 7.37 | 44.4 |
| 272 | 5 | 3 | 11 | 3 | 21 | 0.44 | 0.18 | 0.30 | 0.026 | . | 32.0 | 33 | 12.9 | 3.31 | 0.028 | 0.528 | . | . | . |
| 273 | 5 | 3 | 12 | 1 | 1 | 0.37 | 0.28 | 0.64 | 0.026 | 0.21 | 41.5 | 55 | 13.7 | 2.82 | 0.052 | 1.458 | 0.066 | 8.50 | 34.6 |
| 274 | 5 | 3 | 12 | 1 | 2 | 0.35 | 0.24 | 0.50 | 0.026 | 0.22 | 45.1 | 42 | 10.2 | 2.77 | 0.045 | 1.129 | 0.048 | 9.76 | 49.9 |
| 275 | 5 | 3 | 12 | 1 | 3 | 0.40 | 0.25 | 0.44 | 0.022 | . | 45.5 | 95 | 12.2 | 7.30 | 0.063 | 1.124 | . | . | . |
| 276 | 5 | 3 | 12 | 1 | 4 | 0.35 | 0.22 | 0.42 | 0.027 | 0.14 | 36.1 | 58 | 20.3 | 3.11 | 0.040 | 0.656 | 0.057 | 5.81 | 36.0 |
| 277 | 5 | 3 | 12 | 1 | 5 | 0.30 | 0.28 | 0.50 | 0.039 | 0.09 | 39.5 | 63 | 14.5 | 4.92 | 0.048 | 1.048 | 0.087 | 6.57 | 32.4 |
| 278 | 5 | 3 | 12 | 1 | 6 | 0.37 | 0.24 | 0.45 | 0.027 | 0.15 | 45.9 | 56 | 13.5 | 3.17 | 0.048 | 0.809 | 0.087 | 5.68 | 36.3 |
| 279 | 5 | 3 | 12 | 2 | 7 | 0.47 | 0.19 | 1.30 | 0.036 | . | 74.0 | 63 | 18.5 | 3.47 | 0.076 | 0.766 | . | . | . |
| 280 | 5 | 3 | 12 | 2 | 8 | 0.44 | 0.20 | 1.24 | 0.032 | . | 52.4 | 74 | 27.0 | 2.67 | 0.056 | 1.519 | . | . | . |
| 281 | 5 | 3 | 12 | 2 | 9 | 0.38 | 0.21 | 1.52 | 0.061 | . | 51.7 | 152 | 39.3 | 4.72 | 0.137 | 1.942 | . | . | . |
| 282 | 5 | 3 | 12 | 2 | 10 | 0.38 | 0.23 | 0.32 | 0.033 | 0.12 | 42.8 | 107 | 15.6 | 2.28 | 0.072 | 0.596 | 0.050 | 7.44 | 32.4 |
| 283 | 5 | 3 | 12 | 2 | 11 | 0.33 | 0.15 | 0.28 | 0.033 | 0.13 | 35.7 | 90 | 9.0 | 2.11 | 0.047 | 0.495 | 0.173 | 5.63 | 39.4 |
| 284 | 5 | 3 | 12 | 2 | 12 | 0.40 | 0.22 | 0.42 | 0.031 | 0.14 | 72.4 | 47 | 14.3 | 3.62 | 0.126 | 0.812 | 0.096 | 6.66 | 35.2 |
| 285 | 5 | 3 | 12 | 2 | 13 | 0.35 | 0.17 | 0.40 | 0.035 | 0.18 | 33.4 | 42 | 10.9 | 2.43 | 0.052 | 0.658 | 0.050 | 6.30 | 37.5 |
| 286 | 5 | 3 | 12 | 2 | 14 | 0.36 | 0.20 | 0.51 | 0.056 | 0.20 | 34.2 | 58 | 15.5 | 2.59 | 0.131 | 0.523 | 0.086 | 8.72 | 42.1 |
| 287 | 5 | 3 | 12 | 2 | 15 | 0.29 | 0.20 | 0.44 | 0.035 | . | 28.7 | 30 | 8.9 | 2.93 | 0.048 | 0.282 | . | . | . |
| 288 | 5 | 3 | 12 | 3 | 16 | 0.57 | 0.07 | 0.90 | 0.010 | 0.19 | 41.0 | 38 | 15.8 | 1.51 | 0.059 | 0.572 | 0.067 | 8.41 | 44.1 |
| 289 | 5 | 3 | 12 | 3 | 17 | 0.57 | 0.08 | 1.19 | 0.017 | 0.22 | 53.0 | 63 | 20.8 | 2.75 | 0.059 | 0.577 | 0.057 | 5.59 | 47.3 |
| 290 | 5 | 3 | 12 | 3 | 18 | 0.55 | 0.12 | 1.09 | 0.017 | 0.16 | 65.2 | 64 | 26.3 | 1.78 | 0.063 | 0.373 | 0.067 | 8.50 | 36.0 |
| 291 | 5 | 3 | 12 | 3 | 19 | 0.45 | 0.09 | 1.49 | 0.057 | 0.22 | 48.3 | 35 | 26.2 | 3.09 | 0.054 | 0.782 | 0.043 | 13.23 | 45.8 |
| 292 | 5 | 3 | 12 | 3 | 20 | 0.52 | 0.11 | 0.71 | 0.036 | 0.16 | 37.0 | 51 | 16.4 | 2.28 | 0.057 | 1.138 | 0.077 | 7.48 | 37.9 |
| 293 | 5 | 3 | 12 | 3 | 21 | 0.43 | 0.08 | 1.08 | 0.037 | . | 35.8 | 37 | 18.5 | 1.82 | 0.058 | 0.446 | . | . | . |
| 294 | 5 | 4 | 1 | 1 | 1 | 0.38 | 0.22 | 0.24 | 0.022 | 0.13 | 45.8 | 85 | 20.0 | 1.73 | 0.041 | 1.356 | 0.043 | 6.60 | 35.2 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | CO | MO | SE | CP | IVOMD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 295 | 5 | 4 | 1 | 1 | 2 | 0.39 | 0.18 | 0.18 | 0.014 | 0.07 | 46.8 | 65 | 11.0 | 1.48 | 0.055 | 0.873 | 0.085 | 5.7 | 38.9 |
| 296 | 5 | 4 | 1 | 1 | 3 | 0.44 | 0.17 | 0.23 | 0.011 | 0.12 | 38.3 | 123 | 12.9 | 1.74 | 0.059 | 0.812 | 0.114 | 5.4 | 39.4 |
| 297 | 5 | 4 | 1 | 1 | 4 | 0.46 | 0.19 | 0.24 | 0.014 | 0.12 | 57.3 | 69 | 16.0 | 2.18 | 0.061 | 0.801 | 0.093 | 5.8 | 35.0 |
| 298 | 5 | 4 | 1 | 1 | 5 | 0.32 | 0.19 | 0.30 | 0.017 | 0.12 | 38.7 | 69 | 16.4 | 2.38 | 0.050 | 1.133 | 0.092 | 6.5 | 36.6 |
| 299 | 5 | 4 | 1 | 1 | 6 | 0.35 | 0.19 | 0.21 | 0.013 | . | 34.7 | 83 | 22.6 | 2.36 | 0.061 | 0.799 | . | . | . |
| 300 | 5 | 4 | 1 | 2 | 7 | 0.46 | 0.30 | 0.53 | 0.034 | . | 66.1 | 22 | 15.2 | 3.17 | 0.028 | 2.637 | . | . | . |
| 301 | 5 | 4 | 1 | 2 | 8 | 0.32 | 0.32 | 0.44 | 0.026 | 0.23 | 44.9 | 74 | 15.1 | 3.46 | 0.039 | 2.427 | 0.071 | 12.4 | 55.0 |
| 302 | 5 | 4 | 1 | 2 | 9 | 0.32 | 0.13 | 0.86 | 0.084 | . | 49.8 | 104 | 17.7 | 2.37 | 0.029 | 1.641 | . | . | . |
| 303 | 5 | 4 | 1 | 2 | 10 | 0.38 | 0.15 | 0.20 | 0.012 | 0.10 | 41.1 | 109 | 10.9 | 2.08 | 0.038 | 0.907 | 0.107 | 7.6 | 35.1 |
| 304 | 5 | 4 | 1 | 2 | 11 | 0.44 | 0.15 | 0.15 | 0.014 | 0.05 | 47.3 | 56 | 19.9 | 2.18 | 0.030 | 0.589 | 0.078 | 6.5 | 31.6 |
| 305 | 5 | 4 | 1 | 2 | 12 | 0.42 | 0.17 | 0.32 | 0.017 | . | 41.3 | 43 | 19.6 | 2.26 | 0.039 | 1.098 | . | . | . |
| 306 | 5 | 4 | 1 | 2 | 13 | 0.40 | 0.17 | 0.32 | 0.017 | 0.18 | 48.9 | 40 | 15.7 | 2.30 | 0.031 | 0.689 | 0.071 | 8.7 | 36.4 |
| 307 | 5 | 4 | 1 | 2 | 14 | 0.44 | 0.21 | 0.30 | 0.020 | 0.14 | 59.8 | 49 | 17.6 | 2.47 | 0.049 | 0.812 | 0.085 | 9.5 | 40.1 |
| 308 | 5 | 4 | 1 | 2 | 15 | 0.38 | 0.19 | 0.38 | 0.028 | . | 56.5 | 40 | 15.6 | 2.90 | 0.042 | 0.726 | . | . | . |
| 309 | 5 | 4 | 1 | 3 | 16 | 0.56 | 0.08 | 0.33 | 0.035 | 0.20 | 43.8 | 81 | 20.6 | 3.43 | 0.079 | 0.649 | 0.071 | 7.7 | 37.8 |
| 310 | 5 | 4 | 1 | 3 | 17 | 0.62 | 0.10 | 0.32 | 0.028 | 0.14 | 44.4 | 76 | 18.5 | 2.35 | 0.040 | 0.779 | 0.142 | 7.6 | 34.6 |
| 311 | 5 | 4 | 1 | 3 | 18 | 0.65 | 0.09 | 0.39 | 0.032 | 0.18 | 36.9 | 118 | 24.4 | 2.04 | 0.044 | 0.799 | 0.085 | 7.7 | 38.8 |
| 312 | 5 | 4 | 1 | 3 | 19 | 0.64 | 0.12 | 0.37 | 0.017 | 0.22 | 55.2 | 148 | 16.1 | 2.17 | 0.067 | 0.775 | 0.050 | 7.7 | 38.7 |
| 313 | 5 | 4 | 1 | 3 | 20 | 0.49 | 0.09 | 0.35 | 0.039 | 0.16 | 54.2 | 73 | 10.3 | 3.08 | 0.107 | 0.882 | 0.071 | 7.2 | 38.4 |
| 314 | 5 | 4 | 1 | 3 | 21 | 0.51 | 0.11 | 0.41 | 0.035 | . | 54.6 | 53 | 26.4 | 3.66 | 0.167 | 0.574 | . | . | . |
| 315 | 5 | 4 | 2 | 1 | 1 | 0.31 | 0.19 | 0.44 | 0.015 | 0.14 | 62.1 | 46 | 9.7 | 2.31 | 0.063 | 0.967 | 0.043 | 7.4 | 40.6 |
| 316 | 5 | 4 | 2 | 1 | 2 | 0.36 | 0.12 | 0.27 | 0.012 | 0.10 | 47.9 | 147 | 12.7 | 1.90 | 0.058 | 0.669 | 0.128 | 7.1 | 39.4 |
| 317 | 5 | 4 | 2 | 1 | 3 | 0.41 | 0.17 | 0.24 | 0.015 | 0.12 | 55.8 | 104 | 11.4 | 2.41 | 0.060 | 0.695 | 0.093 | 7.2 | 43.5 |
| 318 | 5 | 4 | 2 | 1 | 4 | 0.34 | 0.15 | 0.47 | 0.013 | 0.14 | 50.4 | 90 | 18.0 | 2.19 | 0.035 | 0.693 | 0.093 | 6.8 | 37.4 |
| 319 | 5 | 4 | 2 | 1 | 5 | 0.37 | 0.18 | 0.21 | 0.012 | 0.11 | 54.6 | 59 | 11.4 | 2.25 | 0.037 | 0.834 | 0.064 | 7.0 | 41.4 |
| 320 | 5 | 4 | 2 | 1 | 6 | 0.40 | 0.16 | 0.26 | 0.008 | . | 53.5 | 40 | 12.0 | 3.03 | 0.029 | 0.782 | . | . | . |
| 321 | 5 | 4 | 2 | 2 | 7 | 0.32 | 0.17 | 1.00 | 0.047 | . | 45.7 | 31 | 9.7 | 1.14 | 0.028 | 1.064 | . | . | . |
| 322 | 5 | 4 | 2 | 2 | 8 | 0.30 | 0.11 | 0.47 | 0.021 | 0.31 | 51.9 | 77 | 22.5 | 1.93 | 0.030 | 0.624 | 0.050 | 13.6 | 56.9 |
| 323 | 5 | 4 | 2 | 2 | 9 | 0.33 | 0.15 | 0.43 | 0.045 | . | 50.9 | 55 | 19.3 | 3.45 | 0.053 | 0.476 | . | . | . |
| 324 | 5 | 4 | 2 | 2 | 10 | 0.40 | 0.14 | 0.98 | 0.017 | 0.16 | 57.8 | 137 | 16.4 | 3.15 | 0.152 | 0.504 | 0.079 | 9.4 | 47.7 |
| 325 | 5 | 4 | 2 | 2 | 11 | 0.44 | 0.14 | 0.48 | 0.012 | 0.15 | 23.1 | 20 | 9.7 | 3.39 | 0.231 | 0.554 | 0.071 | 10.2 | 41.2 |
| 326 | 5 | 4 | 2 | 2 | 12 | 0.29 | 0.15 | 0.31 | 0.013 | . | 31.3 | 22 | 6.9 | 2.30 | 0.039 | 0.317 | . | . | . |
| 327 | 5 | 4 | 2 | 2 | 13 | 0.52 | 0.15 | 0.43 | 0.010 | 0.22 | 47.5 | 24 | 44.5 | 2.49 | 0.045 | 0.032 | 0.017 | 8.8 | 46.5 |
| 328 | 5 | 4 | 2 | 2 | 14 | 0.43 | 0.15 | 0.42 | 0.017 | 0.14 | 60.4 | 37 | 7.6 | 2.40 | 0.095 | 0.775 | 0.170 | 7.9 | 42.0 |
| 329 | 5 | 4 | 2 | 2 | 15 | 0.30 | 0.09 | 0.42 | 0.012 | . | 44.3 | 33 | 6.3 | 1.86 | 0.115 | 0.339 | . | . | . |
| 330 | 5 | 4 | 2 | 3 | 16 | 0.49 | 0.07 | 0.31 | 0.019 | 0.18 | 36.3 | 135 | 14.2 | 1.06 | 0.042 | 0.227 | 0.071 | 7.3 | 44.5 |
| 331 | 5 | 4 | 2 | 3 | 17 | 0.67 | 0.07 | 0.26 | 0.011 | 0.14 | 52.3 | 88 | 26.0 | 1.76 | 0.021 | 0.228 | 0.092 | 7.8 | 41.6 |
| 332 | 5 | 4 | 2 | 3 | 18 | 0.44 | 0.07 | 0.32 | 0.022 | 0.15 | 43.2 | 25 | 7.9 | 1.46 | 0.045 | 0.253 | 0.078 | 7.7 | 42.1 |
| 333 | 5 | 4 | 2 | 3 | 19 | 0.31 | 0.07 | 0.23 | 0.037 | 0.15 | 45.8 | 116 | 15.8 | 1.39 | 0.039 | 0.149 | 0.050 | 6.5 | 36.5 |
| 334 | 5 | 4 | 2 | 3 | 20 | 0.31 | 0.08 | 0.40 | 0.011 | 0.15 | 43.4 | 211 | 19.7 | 1.98 | 0.051 | 0.104 | 0.056 | 8.3 | 40.1 |
| 335 | 5 | 4 | 2 | 3 | 21 | 0.28 | 0.09 | 0.25 | 0.020 | . | 48.1 | 62 | 11.5 | 1.73 | 0.018 | 0.115 | . | . | . |
| 336 | 5 | 4 | 3 | 1 | 1 | 0.37 | 0.25 | 1.91 | 0.036 | 0.39 | 67.5 | 88 | 29.7 | 4.41 | 0.065 | 0.435 | 0.050 | 19.0 | 66.9 |
| 337 | 5 | 4 | 3 | 1 | 2 | 0.37 | 0.32 | 1.31 | 0.023 | 0.22 | 70.2 | 112 | 41.1 | 4.94 | 0.070 | 0.642 | 0.057 | 24.0 | 65.9 |
| 338 | 5 | 4 | 3 | 1 | 3 | 0.31 | 0.19 | 1.82 | 0.028 | 0.26 | 63.9 | 84 | 33.3 | 8.43 | 0.034 | 0.612 | 0.085 | 18.6 | 61.9 |
| 339 | 5 | 4 | 3 | 1 | 4 | 0.23 | 0.15 | 2.03 | 0.046 | 0.24 | 74.1 | 48 | 28.7 | 7.90 | 0.023 | 0.318 | 0.021 | 17.7 | 62.6 |
| 340 | 5 | 4 | 3 | 1 | 5 | 0.17 | 0.16 | 1.29 | 0.041 | 0.16 | 54.7 | 27 | 19.0 | 2.10 | 0.028 | 0.421 | 0.085 | 24.3 | 60.5 |
| 341 | 5 | 4 | 3 | 1 | 6 | 0.25 | 0.18 | 1.63 | 0.035 | . | 54.8 | 88 | 23.5 | 10.28 | 0.047 | 0.191 | . | . | . |
| 342 | 5 | 4 | 3 | 2 | 7 | 0.37 | 0.19 | 0.91 | 0.064 | . | 57.6 | 25 | 20.9 | 4.56 | 0.028 | 1.152 | . | . | . |
| 343 | 5 | 4 | 3 | 2 | 8 | 0.29 | 0.19 | 1.27 | 0.049 | 0.28 | 85.3 | 79 | 34.4 | 5.45 | 0.036 | 0.661 | 0.099 | 16.6 | 63.8 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | CO | MO | SE | CP | IVOMD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 344 | 5 | 4 | 3 | 2 | 9 | 0.30 | 0.18 | 1.08 | 0.058 | . | 50.2 | 129 | 23.8 | 3.35 | 0.043 | 0.418 | . | . | . |
| 345 | 5 | 4 | 3 | 2 | 10 | 0.34 | 0.19 | 0.93 | 0.058 | 0.24 | 80.6 | 135 | 40.3 | 2.59 | 0.055 | 0.146 | 0.036 | 14.5 | 59.9 |
| 346 | 5 | 4 | 3 | 2 | 11 | 0.37 | 0.26 | 0.90 | 0.058 | 0.23 | 57.8 | 260 | 23.0 | 3.85 | 0.214 | 0.166 | 0.043 | 14.3 | 58.6 |
| 347 | 5 | 4 | 3 | 2 | 12 | 0.38 | 0.22 | 0.81 | 0.135 | . | 48.3 | 179 | 36.5 | 4.02 | 0.201 | 0.109 | . | . | . |
| 348 | 5 | 4 | 3 | 2 | 13 | 0.42 | 0.08 | 0.92 | 0.020 | 0.23 | 46.8 | 39 | 24.9 | 2.59 | 0.059 | 0.496 | 0.021 | 11.0 | 49.6 |
| 349 | 5 | 4 | 3 | 2 | 14 | 0.35 | 0.11 | 0.88 | 0.017 | 0.20 | 42.8 | 67 | 25.7 | 2.01 | 0.025 | 0.490 | 0.099 | 11.3 | 52.8 |
| 350 | 5 | 4 | 3 | 2 | 15 | 0.30 | 0.11 | 1.21 | 0.021 | . | 58.7 | 66 | 31.5 | 3.51 | 0.090 | 0.270 | . | . | . |
| 351 | 5 | 4 | 3 | 3 | 16 | 0.44 | 0.07 | 1.48 | 0.037 | 0.26 | 57.8 | 47 | 19.3 | 3.63 | 0.049 | 0.326 | 0.043 | 14.0 | 61.4 |
| 352 | 5 | 4 | 3 | 3 | 17 | 0.41 | 0.11 | 1.96 | 0.055 | 0.23 | 62.2 | 46 | 38.1 | 10.92 | 0.025 | 0.112 | 0.092 | 14.5 | 63.8 |
| 353 | 5 | 4 | 3 | 3 | 18 | 0.37 | 0.10 | 1.32 | 0.053 | 0.24 | 47.3 | 21 | 21.3 | 4.27 | 0.040 | 0.248 | 0.106 | 14.3 | 63.4 |
| 354 | 5 | 4 | 3 | 3 | 19 | 0.48 | 0.08 | 1.51 | 0.042 | 0.24 | 60.5 | 24 | 22.3 | 5.93 | 0.051 | 0.195 | 0.050 | 13.3 | 59.4 |
| 355 | 5 | 4 | 3 | 3 | 20 | 0.41 | 0.09 | 1.53 | 0.017 | 0.21 | 42.3 | 23 | 18.9 | 3.73 | 0.062 | 0.454 | 0.036 | 19.3 | 66.6 |
| 356 | 5 | 4 | 3 | 3 | 21 | 0.39 | 0.06 | 1.37 | 0.024 | . | 44.3 | 47 | 19.3 | 5.69 | 0.026 | 0.107 | . | . | . |
| 357 | 5 | 4 | 4 | 1 | 1 | 0.40 | 0.20 | 0.55 | 0.034 | 0.22 | 41.7 | 78 | 12.1 | 1.67 | 0.037 | 0.751 | 0.050 | 9.0 | 51.9 |
| 358 | 5 | 4 | 4 | 1 | 2 | 0.35 | 0.19 | 0.72 | 0.032 | 0.20 | 43.7 | 120 | 16.1 | 1.58 | 0.087 | 0.655 | 0.196 | 11.2 | 51.1 |
| 359 | 5 | 4 | 4 | 1 | 3 | 0.34 | 0.18 | 1.06 | 0.051 | 0.16 | 53.5 | 61 | 17.2 | 1.82 | 0.052 | 0.893 | 0.105 | 13.2 | 57.5 |
| 360 | 5 | 4 | 4 | 1 | 4 | 0.25 | 0.19 | 0.58 | 0.030 | 0.16 | 33.0 | 34 | 10.4 | 1.68 | 0.036 | 0.907 | 0.036 | 10.5 | 56.9 |
| 361 | 5 | 4 | 4 | 1 | 5 | 0.46 | 0.19 | 1.10 | 0.044 | 0.07 | 46.4 | 7 | 12.2 | 1.87 | 0.045 | 1.189 | 0.147 | 8.3 | 45.3 |
| 362 | 5 | 4 | 4 | 1 | 6 | 0.30 | 0.23 | 0.82 | 0.041 | . | 47.2 | 14 | 8.8 | 0.94 | 0.026 | 1.531 | . | . | . |
| 363 | 5 | 4 | 4 | 2 | 7 | 0.35 | 0.15 | 0.70 | 0.043 | . | 40.0 | 68 | 9.5 | 1.44 | 0.042 | 1.023 | . | . | . |
| 364 | 5 | 4 | 4 | 2 | 8 | 0.33 | 0.20 | 0.84 | 0.021 | 0.21 | 49.0 | 72 | 15.1 | 1.74 | 0.044 | 0.968 | 0.196 | 10.2 | 54.1 |
| 365 | 5 | 4 | 4 | 2 | 9 | 0.44 | 0.19 | 0.38 | 0.100 | . | 40.8 | 41 | 7.4 | 1.80 | 0.033 | 1.615 | . | . | . |
| 366 | 5 | 4 | 4 | 2 | 10 | 0.28 | 0.10 | 0.34 | 0.045 | 0.09 | 38.5 | 20 | 4.2 | 1.21 | 0.043 | 0.456 | 0.052 | 7.0 | 40.7 |
| 367 | 5 | 4 | 4 | 2 | 11 | 0.29 | 0.13 | 0.41 | 0.030 | 0.07 | 33.6 | 43 | 4.2 | 1.07 | 0.022 | 0.630 | 0.049 | 7.6 | 48.4 |
| 368 | 5 | 4 | 4 | 2 | 12 | 0.33 | 0.12 | 0.34 | 0.038 | . | 42.4 | 109 | 7.9 | 1.46 | 0.036 | 0.628 | . | . | . |
| 369 | 5 | 4 | 4 | 2 | 13 | 0.31 | 0.22 | 0.64 | 0.034 | 0.19 | 38.2 | 99 | 19.6 | 2.64 | 0.048 | 0.339 | 0.142 | 10.3 | 52.1 |
| 370 | 5 | 4 | 4 | 2 | 14 | 0.31 | 0.20 | 0.85 | 0.039 | 0.19 | 49.8 | 93 | 16.6 | 1.54 | 0.052 | 0.247 | 0.063 | 10.7 | 53.7 |
| 371 | 5 | 4 | 4 | 2 | 15 | 0.32 | 0.15 | 0.78 | 0.042 | . | 46.3 | 93 | 25.9 | 1.51 | 0.079 | 0.221 | . | . | . |
| 372 | 5 | 4 | 4 | 3 | 16 | 0.39 | 0.18 | 0.30 | 0.016 | 0.17 | 52.8 | 33 | 23.0 | 2.52 | 0.033 | 1.216 | 0.050 | 7.9 | 41.7 |
| 373 | 5 | 4 | 4 | 3 | 17 | 0.54 | 0.15 | 0.48 | 0.015 | 0.10 | 67.0 | 20 | 22.6 | 1.63 | 0.033 | 0.918 | 0.245 | 9.3 | 42.9 |
| 374 | 5 | 4 | 4 | 3 | 18 | 0.46 | 0.16 | 0.48 | 0.027 | 0.05 | 47.9 | 24 | 14.6 | 2.15 | 0.031 | 1.363 | 0.070 | 9.7 | 47.4 |
| 375 | 5 | 4 | 4 | 3 | 19 | 0.31 | 0.11 | 0.41 | 0.021 | 0.18 | 41.0 | 49 | 8.6 | 1.95 | 0.059 | 0.536 | 0.106 | 8.3 | 41.4 |
| 376 | 5 | 4 | 4 | 3 | 20 | 0.42 | 0.14 | 0.54 | 0.019 | 0.17 | 54.4 | 67 | 14.9 | 2.11 | 0.056 | 0.666 | 0.209 | 8.3 | 45.5 |
| 377 | 5 | 4 | 4 | 3 | 21 | 0.43 | 0.16 | 0.60 | 0.019 | . | 59.8 | 44 | 13.4 | 2.21 | 0.052 | 0.889 | . | . | . |
| 378 | 5 | 4 | 5 | 1 | 1 | 0.49 | 0.20 | 0.96 | 0.055 | 0.19 | 43.6 | 92 | 23.9 | 4.26 | 0.030 | 0.517 | 0.042 | 8.1 | 50.5 |
| 379 | 5 | 4 | 5 | 1 | 2 | 0.38 | 0.13 | 0.89 | 0.059 | 0.13 | 31.8 | 42 | 13.6 | 2.62 | 0.022 | 0.426 | 0.105 | 8.5 | 46.3 |
| 380 | 5 | 4 | 5 | 1 | 3 | 0.40 | 0.16 | 1.12 | 0.057 | 0.18 | 38.7 | 99 | 25.3 | 4.77 | 0.066 | 0.974 | 0.035 | 9.4 | 49.3 |
| 381 | 5 | 4 | 5 | 1 | 4 | 0.41 | 0.22 | 1.03 | 0.029 | 0.22 | 38.9 | 45 | 67.1 | 3.89 | 0.032 | 0.485 | 0.043 | 8.9 | 53.3 |
| 382 | 5 | 4 | 5 | 1 | 5 | 0.32 | 0.20 | 0.81 | 0.023 | 0.18 | 24.6 | 34 | 13.5 | 2.15 | 0.021 | 0.692 | 0.042 | 8.6 | 49.2 |
| 383 | 5 | 4 | 5 | 1 | 6 | 0.36 | 0.25 | 1.04 | 0.058 | . | 42.1 | 52 | 22.0 | 4.43 | 0.017 | 0.853 | . | . | . |
| 384 | 5 | 4 | 5 | 2 | 7 | 0.41 | 0.28 | 1.52 | 0.033 | . | 50.6 | 53 | 32.8 | 5.62 | 0.034 | 0.812 | . | . | . |
| 385 | 5 | 4 | 5 | 2 | 8 | 0.26 | 0.25 | 1.07 | 0.040 | 0.23 | 43.7 | 40 | 42.2 | 6.38 | 0.024 | 0.185 | 0.035 | 12.6 | 52.2 |
| 386 | 5 | 4 | 5 | 2 | 9 | 0.38 | 0.21 | 0.85 | 0.040 | . | 51.4 | 59 | 26.6 | 6.36 | 0.026 | 0.585 | . | . | . |
| 387 | 5 | 4 | 5 | 2 | 10 | 0.46 | 0.20 | 0.98 | 0.034 | 0.24 | 51.7 | 34 | 23.7 | 5.22 | 0.021 | 0.575 | 0.034 | 10.7 | 54.9 |
| 388 | 5 | 4 | 5 | 2 | 11 | 0.44 | 0.41 | 0.89 | 0.057 | 0.23 | 53.9 | 33 | 23.4 | 5.34 | 0.038 | 0.609 | 0.042 | 10.2 | 50.6 |
| 389 | 5 | 4 | 5 | 2 | 12 | 0.46 | 0.33 | 1.15 | 0.047 | . | 44.0 | 51 | 21.0 | 5.74 | 0.032 | 0.252 | . | . | . |
| 390 | 5 | 4 | 5 | 2 | 13 | 0.47 | 0.18 | 1.31 | 0.036 | 0.22 | 45.3 | 39 | 21.4 | 4.53 | 0.022 | 0.088 | 0.081 | 9.2 | 52.9 |
| 391 | 5 | 4 | 5 | 2 | 14 | 0.45 | 0.21 | 1.06 | 0.049 | 0.20 | 46.5 | 23 | 14.0 | 4.54 | 0.045 | 0.251 | 0.084 | 9.5 | 48.0 |
| 392 | 5 | 4 | 5 | 2 | 15 | 0.47 | 0.23 | 0.96 | 0.057 | . | 48.9 | 28 | 17.1 | 5.98 | 0.049 | 0.299 | . | . | . |

| OBS | SAM | YR | MTH | TR | 08 | CA | MG | K | NA | P | FE | MN | ZN | CU | CO | MO | SE | CP | IVOMD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 393 | 5 | 4 | 5 | 3 | 16 | 0.43 | 0.16 | 1.26 | 0.071 | 0.23 | 42.4 | 17 | 14.1 | 4.03 | 0.032 | 0.277 | 0.047 | 9.1 | 58.3 |
| 394 | 5 | 4 | 5 | 3 | 17 | 0.43 | 0.15 | 1.18 | 0.059 | 0.21 | 39.8 | 13 | 16.8 | 3.61 | 0.035 | 0.570 | 0.105 | 9.8 | 53.5 |
| 395 | 5 | 4 | 5 | 3 | 18 | 0.29 | 0.21 | 1.23 | 0.049 | 0.29 | 34.6 | 14 | 13.5 | 2.18 | 0.035 | 0.681 | 0.070 | 12.1 | 58.5 |
| 396 | 5 | 4 | 5 | 3 | 19 | 0.48 | 0.13 | 1.19 | 0.060 | 0.26 | 37.7 | 16 | 11.1 | 1.83 | 0.052 | 0.687 | 0.054 | 8.7 | 59.6 |
| 397 | 5 | 4 | 5 | 3 | 20 | 0.43 | 0.09 | 1.03 | 0.068 | 0.22 | 28.9 | 12 | 7.9 | 2.06 | 0.035 | 0.139 | 0.126 | 10.5 | 55.4 |
| 398 | 5 | 4 | 5 | 3 | 21 | 0.48 | 0.13 | 1.41 | 0.050 | . | 43.4 | 14 | 14.5 | 2.56 | 0.051 | 0.217 | . | . | . |
| 399 | 5 | 4 | 6 | 1 | 1 | 0.31 | 0.05 | 0.29 | 0.065 | 0.27 | 60.1 | 13 | 25.6 | 4.27 | 0.035 | 0.910 | 0.040 | 11.0 | 57.7 |
| 400 | 5 | 4 | 6 | 1 | 2 | 0.19 | 0.17 | 0.44 | 0.044 | 0.20 | 35.4 | 36 | 15.6 | 3.87 | 0.033 | 1.108 | 0.070 | 10.6 | 51.3 |
| 401 | 5 | 4 | 6 | 1 | 3 | 0.11 | 0.09 | 0.48 | 0.069 | 0.15 | 50.5 | 26 | 12.7 | 3.27 | 0.031 | 0.139 | 0.035 | 12.6 | 58.5 |
| 402 | 5 | 4 | 6 | 1 | 4 | 0.11 | 0.13 | 0.38 | 0.055 | 0.23 | 37.5 | 53 | 16.6 | 2.58 | 0.051 | 0.475 | 0.094 | 9.5 | 54.4 |
| 403 | 5 | 4 | 6 | 1 | 5 | 0.20 | 0.15 | 0.61 | 0.071 | 0.19 | 31.4 | 63 | 30.6 | 3.48 | 0.059 | 0.308 | 0.063 | 8.8 | 48.9 |
| 404 | 5 | 4 | 6 | 1 | 6 | 0.19 | 0.18 | 0.63 | 0.050 | . | 35.5 | 52 | 17.9 | 3.20 | 0.031 | 1.119 | . | . | . |
| 405 | 5 | 4 | 6 | 2 | 7 | 0.19 | 0.21 | 0.60 | 0.068 | . | 48.7 | 12 | 23.5 | 3.48 | 0.040 | 1.899 | . | . | . |
| 406 | 5 | 4 | 6 | 2 | 8 | 0.21 | 0.18 | 0.56 | 0.074 | 0.17 | 52.8 | 19 | 20.7 | 4.34 | 0.035 | 1.350 | 0.105 | 11.3 | 57.9 |
| 407 | 5 | 4 | 6 | 2 | 9 | 0.17 | 0.17 | 1.55 | 0.055 | . | 48.7 | 45 | 45.7 | 6.68 | 0.036 | 0.335 | . | . | . |
| 408 | 5 | 4 | 6 | 2 | 10 | 0.25 | 0.21 | 0.44 | 0.097 | 0.14 | 37.6 | 46 | 9.8 | 4.16 | 0.039 | 0.168 | 0.081 | 8.1 | 50.5 |
| 409 | 5 | 4 | 6 | 2 | 11 | 0.32 | 0.05 | 0.19 | 0.036 | 0.13 | 46.0 | 54 | 29.3 | 3.46 | 0.044 | 0.260 | 0.077 | 10.8 | 55.5 |
| 410 | 5 | 4 | 6 | 2 | 12 | 0.10 | 0.12 | 0.28 | 0.076 | . | 44.2 | 35 | 12.4 | 4.04 | 0.039 | 0.218 | . | . | . |
| 411 | 5 | 4 | 6 | 2 | 13 | 0.16 | 0.06 | 0.42 | 0.034 | 0.17 | 27.4 | 19 | 14.5 | 3.16 | 0.031 | 0.378 | 0.068 | 7.2 | 52.1 |
| 412 | 5 | 4 | 6 | 2 | 14 | 0.04 | 0.05 | 0.17 | 0.047 | 0.15 | 34.4 | 27 | 14.1 | 3.08 | 0.031 | 0.540 | 0.077 | 8.0 | 52.7 |
| 413 | 5 | 4 | 6 | 2 | 15 | 0.39 | 0.20 | 0.66 | 0.026 | . | 30.8 | 24 | 10.7 | 3.30 | 0.029 | 0.475 | . | . | . |
| 414 | 5 | 4 | 6 | 3 | 16 | 0.28 | 0.15 | 1.16 | 0.070 | 0.24 | 33.7 | 21 | 21.8 | 5.32 | 0.025 | 0.521 | 0.088 | 10.5 | 55.9 |
| 415 | 5 | 4 | 6 | 3 | 17 | 0.10 | 0.07 | 0.44 | 0.017 | 0.20 | 41.0 | 23 | 22.0 | 3.84 | 0.030 | 0.379 | 0.042 | 9.8 | 54.7 |
| 416 | 5 | 4 | 6 | 3 | 18 | 0.38 | 0.19 | 1.44 | 0.056 | 0.18 | 55.5 | 20 | 24.0 | 4.89 | 0.040 | 0.244 | 0.035 | 12.5 | 61.4 |
| 417 | 5 | 4 | 6 | 3 | 19 | 0.37 | 0.13 | 1.62 | 0.023 | 0.25 | 59.4 | 16 | 27.1 | 7.54 | 0.055 | 0.253 | 0.054 | 14.0 | 65.0 |
| 418 | 5 | 4 | 6 | 3 | 20 | 0.05 | 0.04 | 0.29 | 0.015 | 0.24 | 40.3 | 14 | 19.5 | 4.44 | 0.051 | 0.323 | 0.084 | 10.7 | 58.5 |
| 419 | 5 | 4 | 6 | 3 | 21 | 0.42 | 0.14 | 1.25 | 0.051 | . | 95.0 | 31 | 95.9 | 3.44 | 0.105 | 1.031 | . | . | . |
| 420 | 5 | 4 | 7 | 1 | 1 | 0.30 | 0.27 | 1.12 | 0.056 | 0.21 | 38.9 | 54 | 25.2 | 4.20 | 0.020 | 1.153 | 0.041 | 10.8 | 52.7 |
| 421 | 5 | 4 | 7 | 1 | 2 | 0.26 | 0.26 | 1.08 | 0.028 | 0.24 | 70.2 | 29 | 14.7 | 2.70 | 0.030 | 0.692 | 0.023 | 10.6 | 48.5 |
| 422 | 5 | 4 | 7 | 1 | 3 | 0.10 | 0.26 | 1.78 | 0.047 | 0.17 | 46.9 | 33 | 17.8 | 3.59 | 0.024 | 0.135 | 0.026 | 12.7 | 50.5 |
| 423 | 5 | 4 | 7 | 1 | 4 | 0.21 | 0.35 | 0.85 | 0.026 | 0.28 | 37.8 | 78 | 20.5 | 3.39 | 0.085 | 1.160 | 0.047 | 8.5 | 51.0 |
| 424 | 5 | 4 | 7 | 1 | 5 | 0.16 | 0.22 | 1.45 | 0.030 | 0.29 | 33.3 | 60 | 26.7 | 4.32 | 0.014 | 0.944 | 0.040 | 11.5 | 52.0 |
| 425 | 5 | 4 | 7 | 1 | 6 | 0.26 | 0.32 | 1.06 | 0.035 | . | 34.7 | 64 | 20.7 | 2.85 | 0.050 | 1.497 | . | . | . |
| 426 | 5 | 4 | 7 | 2 | 7 | 0.25 | 0.28 | 0.84 | 0.035 | 0.29 | 40.6 | 60 | 15.3 | 2.98 | 0.011 | 0.763 | 0.054 | 9.7 | 53.5 |
| 427 | 5 | 4 | 7 | 2 | 8 | 0.27 | 0.30 | 1.38 | 0.063 | 0.22 | 60.0 | 55 | 26.0 | 3.91 | 0.012 | 0.957 | 0.223 | 9.3 | 50.6 |
| 428 | 5 | 4 | 7 | 2 | 9 | 0.36 | 0.31 | 0.96 | 0.033 | . | 55.2 | 24 | 15.1 | 4.31 | 0.020 | 1.430 | . | . | . |
| 429 | 5 | 4 | 7 | 2 | 10 | 0.36 | 0.40 | 0.71 | 0.036 | . | 39.9 | 83 | 15.2 | 4.31 | 0.052 | 0.601 | . | . | . |
| 430 | 5 | 4 | 7 | 2 | 11 | 0.36 | 0.30 | 0.93 | 0.111 | 0.10 | 51.9 | 40 | 24.5 | 6.39 | 0.037 | 0.383 | 0.029 | 10.2 | 51.3 |
| 431 | 5 | 4 | 7 | 2 | 12 | 0.34 | 0.36 | 0.80 | 0.007 | . | 48.3 | 30 | 23.0 | 4.32 | 0.073 | 0.551 | . | . | . |
| 432 | 5 | 4 | 7 | 2 | 13 | 0.47 | 0.23 | 1.02 | 0.028 | 0.22 | 53.7 | 33 | 22.4 | 3.74 | 0.024 | 0.439 | 0.040 | 6.9 | 49.1 |
| 433 | 5 | 4 | 7 | 2 | 14 | 0.45 | 0.22 | 1.17 | 0.040 | 0.16 | 37.0 | 34 | 21.5 | 3.85 | 0.030 | 0.621 | 0.022 | 8.2 | 45.5 |
| 434 | 5 | 4 | 7 | 2 | 15 | 0.45 | 0.27 | 1.04 | 0.036 | . | 37.9 | 37 | 16.0 | 3.68 | 0.022 | 0.505 | . | . | . |
| 435 | 5 | 4 | 7 | 3 | 16 | 0.36 | 0.20 | 1.44 | 0.053 | 0.24 | 39.0 | 14 | 20.3 | 4.45 | 0.043 | 0.635 | 0.041 | 9.3 | 53.2 |
| 436 | 5 | 4 | 7 | 3 | 17 | 0.35 | 0.20 | 1.50 | 0.021 | 0.28 | 44.7 | 17 | 23.2 | 6.47 | 0.035 | 0.524 | 0.120 | 10.4 | 51.6 |
| 437 | 5 | 4 | 7 | 3 | 18 | 0.30 | 0.18 | 1.07 | 0.053 | 0.24 | 61.7 | 12 | 13.8 | 3.06 | 0.126 | 0.546 | 0.057 | 10.7 | 51.5 |
| 438 | 5 | 4 | 7 | 3 | 19 | 0.33 | 0.20 | 1.38 | 0.046 | 0.35 | 56.7 | 15 | 18.9 | 4.03 | 0.069 | 0.517 | 0.040 | 10.6 | 57.3 |
| 439 | 5 | 4 | 7 | 3 | 20 | 0.33 | 0.18 | 1.38 | 0.039 | 0.32 | 41.7 | 16 | 17.6 | 5.20 | 0.052 | 0.526 | 0.039 | 11.7 | 56.0 |
| 440 | 5 | 4 | 7 | 3 | 21 | 0.37 | 0.19 | 1.39 | 0.023 | . | 48.7 | 27 | 23.1 | 7.52 | 0.102 | 0.249 | . | . | . |
| 441 | 5 | 4 | 8 | 1 | 1 | 0.11 | 0.23 | 1.33 | 0.061 | 0.17 | 42.0 | 38 | 20.2 | 3.24 | 0.028 | 0.430 | 0.041 | 8.9 | 50.3 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | CO | MO | SE | CP | IVOMD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 442 | 5 | 4 | 8 | 1 | 2 | 0.21 | 0.28 | 1.07 | 0.010 | 0.20 | 35.8 | 8 | 12.6 | 2.52 | 0.010 | 0.699 | 0.040 | 9.4 | 45.8 |
| 443 | 5 | 4 | 8 | 1 | 3 | 0.20 | 0.21 | 0.53 | 0.027 | 0.22 | 16.0 | 5 | 7.5 | 1.11 | 0.006 | 0.631 | 0.028 | 8.3 | 47.8 |
| 444 | 5 | 4 | 8 | 1 | 4 | 0.25 | 0.25 | 0.44 | 0.037 | 0.19 | 28.3 | 34 | 9.6 | 2.39 | 0.016 | 0.368 | 0.033 | 9.0 | 46.8 |
| 445 | 5 | 4 | 8 | 1 | 5 | 0.13 | 0.23 | 1.17 | 0.028 | 0.11 | 37.7 | 30 | 17.0 | 3.34 | 0.031 | 0.058 | 0.028 | 10.1 | 44.6 |
| 446 | 5 | 4 | 8 | 1 | 6 | 0.20 | 0.28 | 0.91 | 0.030 | . | 33.4 | 38 | 15.9 | 2.46 | 0.026 | 0.563 | . | . | . |
| 447 | 5 | 4 | 8 | 2 | 7 | 0.28 | 0.27 | 0.95 | 0.016 | . | 46.6 | 12 | 13.2 | 3.14 | 0.011 | 0.886 | . | . | . |
| 448 | 5 | 4 | 8 | 2 | 8 | 0.20 | 0.22 | 0.78 | 0.041 | 0.22 | 33.4 | 19 | 12.6 | 2.10 | 0.004 | 0.344 | 0.068 | 9.5 | 47.3 |
| 449 | 5 | 4 | 8 | 2 | 9 | 0.22 | 0.29 | 0.76 | 0.041 | . | 34.0 | 19 | 12.8 | 1.92 | 0.018 | 0.893 | . | . | . |
| 450 | 5 | 4 | 8 | 2 | 10 | 0.29 | 0.39 | 0.42 | 0.025 | 0.28 | 40.9 | 54 | 11.7 | 2.96 | 0.005 | 0.131 | 0.074 | 12.2 | 56.4 |
| 451 | 5 | 4 | 8 | 2 | 11 | 0.29 | 0.42 | 0.66 | 0.036 | 0.15 | 41.1 | 41 | 15.9 | 3.90 | 0.032 | 0.411 | 0.052 | 9.9 | 47.6 |
| 452 | 5 | 4 | 8 | 2 | 12 | 0.32 | 0.37 | 0.42 | 0.044 | . | 37.2 | 61 | 9.4 | 2.78 | 0.101 | 0.395 | . | . | . |
| 453 | 5 | 4 | 8 | 2 | 13 | 0.33 | 0.21 | 0.87 | 0.036 | 0.22 | 33.6 | 21 | 17.9 | 2.75 | 0.050 | 0.270 | 0.047 | 6.6 | 45.2 |
| 454 | 5 | 4 | 8 | 2 | 14 | 0.28 | 0.19 | 0.58 | 0.035 | 0.18 | 30.6 | 14 | 9.6 | 2.02 | 0.044 | 0.323 | 0.046 | 7.6 | 40.9 |
| 455 | 5 | 4 | 8 | 2 | 15 | 0.36 | 0.21 | 0.82 | 0.034 | . | 33.2 | 19 | 11.6 | 2.90 | 0.047 | 0.348 | . | . | . |
| 456 | 5 | 4 | 8 | 3 | 16 | 0.26 | 0.17 | 1.23 | 0.055 | 0.35 | 56.7 | 11 | 19.2 | 3.92 | 0.103 | 0.062 | 0.067 | 9.3 | 52.4 |
| 457 | 5 | 4 | 8 | 3 | 17 | 0.30 | 0.15 | 1.27 | 0.039 | 0.26 | 38.3 | 8 | 15.9 | 3.44 | 0.060 | 0.100 | 0.029 | 9.5 | 52.8 |
| 458 | 5 | 4 | 8 | 3 | 18 | 0.27 | 0.15 | 1.32 | 0.026 | 0.28 | 51.3 | 11 | 18.6 | 2.67 | 0.085 | 0.115 | 0.035 | 11.0 | 55.8 |
| 459 | 5 | 4 | 8 | 3 | 19 | 0.38 | 0.20 | 1.30 | 0.032 | 0.33 | 47.2 | 10 | 13.6 | 3.28 | 0.063 | 0.303 | 0.047 | 9.1 | 54.1 |
| 460 | 5 | 4 | 8 | 3 | 20 | 0.27 | 0.14 | 1.78 | 0.016 | 0.21 | 47.1 | 10 | 24.6 | 5.19 | 0.076 | 0.353 | 0.034 | 10.7 | 51.6 |
| 461 | 5 | 4 | 8 | 3 | 21 | 0.28 | 0.18 | 1.35 | 0.026 | . | 42.9 | 13 | 16.7 | 2.36 | 0.069 | 0.308 | . | . | . |
| 462 | 5 | 4 | 9 | 1 | 1 | 0.09 | 0.27 | 1.12 | 0.044 | 0.17 | 35.4 | 68 | 10.4 | 2.08 | 0.059 | 0.120 | 0.061 | 9.2 | 48.6 |
| 463 | 5 | 4 | 9 | 1 | 2 | 0.27 | 0.23 | 0.38 | 0.059 | 0.09 | 31.4 | 37 | 15.3 | 2.00 | 0.041 | 0.270 | 0.063 | 8.4 | 41.4 |
| 464 | 5 | 4 | 9 | 1 | 3 | 0.14 | 0.30 | 1.03 | 0.043 | 0.18 | 32.3 | 40 | 20.5 | 1.79 | 0.049 | 0.486 | 0.046 | 8.2 | 40.5 |
| 465 | 5 | 4 | 9 | 1 | 4 | 0.29 | 0.29 | 0.71 | 0.057 | 0.23 | 34.5 | 48 | 14.5 | 1.70 | 0.058 | 0.239 | 0.067 | 7.8 | 44.6 |
| 466 | 5 | 4 | 9 | 1 | 5 | 0.29 | 0.28 | 0.92 | 0.047 | 0.21 | 30.8 | 31 | 14.1 | 1.91 | 0.032 | 0.260 | 0.093 | 9.2 | 43.6 |
| 467 | 5 | 4 | 9 | 1 | 6 | 0.34 | 0.37 | 0.73 | 0.046 | . | 31.9 | 54 | 12.4 | 3.24 | 0.046 | 0.376 | . | . | . |
| 468 | 5 | 4 | 9 | 2 | 7 | 0.33 | 0.25 | 0.96 | 0.055 | 0.21 | 48.6 | 9 | 13.6 | 2.76 | 0.040 | 0.988 | 0.067 | 7.4 | 41.1 |
| 469 | 5 | 4 | 9 | 2 | 8 | 0.30 | 0.30 | 0.93 | 0.038 | 0.19 | 41.8 | 20 | 19.0 | 2.24 | 0.042 | 0.586 | 0.035 | 8.3 | 36.6 |
| 470 | 5 | 4 | 9 | 2 | 9 | 0.31 | 0.32 | 0.70 | 0.069 | . | 45.2 | 18 | 9.0 | 4.32 | 0.058 | 0.700 | . | . | . |
| 471 | 5 | 4 | 9 | 2 | 10 | 0.31 | 0.46 | 0.28 | 0.047 | . | 36.9 | 40 | 12.1 | 3.63 | 0.047 | 0.502 | . | . | . |
| 472 | 5 | 4 | 9 | 2 | 11 | 0.19 | 0.32 | 0.14 | 0.026 | 0.19 | 36.9 | 73 | 9.0 | 4.22 | 0.047 | 0.395 | 0.023 | 8.9 | 43.7 |
| 473 | 5 | 4 | 9 | 2 | 12 | 0.35 | 0.33 | 0.93 | 0.036 | 0.16 | 41.6 | 48 | 8.0 | 2.47 | 0.046 | 0.190 | 0.054 | 7.2 | 43.9 |
| 474 | 5 | 4 | 9 | 2 | 13 | 0.36 | 0.26 | 0.74 | 0.036 | . | 33.2 | 35 | 14.6 | 2.62 | 0.079 | 0.241 | . | . | . |
| 475 | 5 | 4 | 9 | 2 | 14 | 0.24 | 0.21 | 0.65 | 0.028 | 0.23 | 26.2 | 30 | 7.7 | 0.79 | 0.069 | 0.094 | 0.034 | 9.2 | 41.2 |
| 476 | 5 | 4 | 9 | 2 | 15 | 0.36 | 0.29 | 0.79 | 0.034 | . | 34.5 | 47 | 17.1 | 2.99 | 0.105 | 0.392 | . | . | . |
| 477 | 5 | 4 | 9 | 3 | 16 | 0.49 | 0.18 | 1.04 | 0.055 | 0.32 | 44.8 | 8 | 13.6 | 2.46 | 0.049 | 0.197 | 0.047 | 9.9 | 49.7 |
| 478 | 5 | 4 | 9 | 3 | 17 | 0.37 | 0.15 | 0.73 | 0.057 | 0.31 | 39.2 | 12 | 10.1 | 1.64 | 0.052 | 0.048 | 0.029 | 9.7 | 44.6 |
| 479 | 5 | 4 | 9 | 3 | 18 | 0.24 | 0.14 | 0.40 | 0.027 | 0.31 | 43.4 | 32 | 26.4 | 1.87 | 0.045 | 0.025 | 0.035 | 10.6 | 49.0 |
| 480 | 5 | 4 | 9 | 3 | 19 | 0.37 | 0.15 | 0.99 | 0.040 | 0.26 | 50.8 | 11 | 53.9 | 2.13 | 0.066 | 0.147 | 0.054 | 10.3 | 50.4 |
| 481 | 5 | 4 | 9 | 3 | 20 | 0.22 | 0.10 | 0.55 | 0.049 | 0.29 | 34.3 | 7 | 3.8 | 1.14 | 0.046 | 0.224 | 0.052 | 10.2 | 50.4 |
| 482 | 5 | 4 | 9 | 3 | 21 | 0.34 | 0.17 | 0.78 | 0.068 | . | 47.9 | 6 | 7.8 | 3.36 | 0.037 | 0.248 | . | . | . |
| 483 | 5 | 4 | 10 | 1 | 1 | 0.17 | 0.12 | 0.32 | 0.080 | 0.11 | 41.3 | 23 | 13.3 | 1.61 | 0.057 | 0.515 | 0.068 | 8.2 | 41.3 |
| 484 | 5 | 4 | 10 | 1 | 2 | 0.29 | 0.21 | 0.35 | 0.064 | 0.18 | 39.2 | 56 | 12.4 | 2.39 | 0.067 | 0.779 | 0.034 | 7.9 | 38.3 |
| 485 | 5 | 4 | 10 | 1 | 3 | 0.13 | 0.17 | 0.43 | 0.064 | 0.22 | 29.0 | 47 | 11.6 | 2.67 | 0.057 | 0.358 | 0.045 | 8.6 | 34.2 |
| 486 | 5 | 4 | 10 | 1 | 4 | 0.07 | 0.07 | 0.22 | 0.059 | 0.13 | 33.1 | 45 | 11.4 | 1.10 | 0.057 | 0.673 | 0.074 | 5.7 | 39.4 |
| 487 | 5 | 4 | 10 | 1 | 5 | 0.10 | 0.11 | 0.23 | 0.069 | 0.15 | 34.9 | 56 | 13.5 | 1.89 | 0.058 | 0.367 | 0.056 | 7.5 | 34.7 |
| 488 | 5 | 4 | 10 | 1 | 6 | 0.26 | 0.24 | 0.53 | 0.059 | . | 32.3 | 22 | 7.3 | 1.43 | 0.049 | 0.345 | . | . | . |
| 489 | 5 | 4 | 10 | 2 | 7 | 0.29 | 0.18 | 0.76 | 0.067 | 0.22 | 63.8 | 30 | 15.8 | 2.07 | 0.057 | 0.823 | 0.034 | 8.4 | 41.1 |
| 490 | 5 | 4 | 10 | 2 | 8 | 0.24 | 0.18 | 1.21 | 0.074 | 0.17 | 43.1 | 35 | 18.5 | 2.37 | 0.062 | 0.647 | 0.067 | 10.9 | 37.2 |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | CO | MO | SE | CP | IVOMD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 491 | 5 | 4 | 10 | 2 | 9 | 0.34 | 0.19 | 0.82 | 0.066 | . | 43.2 | 14 | 14.1 | 2.52 | 0.046 | 0.627 | . | . | . |
| 492 | 5 | 4 | 10 | 2 | 10 | 0.28 | 0.20 | 0.63 | 0.068 | . | 38.8 | 67 | 17.8 | 2.86 | 0.066 | 0.518 | . | . | . |
| 493 | 5 | 4 | 10 | 2 | 11 | 0.26 | 0.22 | 0.45 | 0.071 | . | 33.0 | 68 | 9.2 | 2.54 | 0.059 | 0.589 | . | . | . |
| 494 | 5 | 4 | 10 | 2 | 12 | 0.32 | 0.22 | 0.38 | 0.088 | 0.17 | 40.7 | 87 | 15.8 | 2.77 | 0.104 | 0.662 | 0.045 | 7.2 | 33.7 |
| 495 | 5 | 4 | 10 | 2 | 13 | 0.46 | 0.03 | 0.12 | 0.069 | 0.23 | 39.4 | 84 | 26.6 | 2.70 | 0.074 | 0.580 | 0.041 | 9.8 | 36.8 |
| 496 | 5 | 4 | 10 | 2 | 14 | 0.36 | 0.26 | 0.41 | 0.070 | 0.17 | 35.1 | 100 | 15.7 | 2.65 | 0.089 | 1.439 | 0.067 | 8.3 | 37.0 |
| 497 | 5 | 4 | 10 | 2 | 15 | 0.12 | 0.12 | 0.39 | 0.080 | . | 44.8 | 62 | 19.3 | 2.03 | 0.082 | 0.924 | . | . | . |
| 498 | 5 | 4 | 10 | 3 | 16 | 0.19 | 0.17 | 0.27 | 0.071 | 0.20 | 27.3 | 57 | 19.4 | 2.29 | 0.047 | 0.595 | 0.082 | 8.4 | 50.7 |
| 499 | 5 | 4 | 10 | 3 | 17 | 0.40 | 0.27 | 0.53 | 0.069 | 0.14 | 44.8 | 67 | 14.6 | 3.41 | 0.072 | 0.512 | 0.072 | 10.5 | 50.1 |
| 500 | 5 | 4 | 10 | 3 | 18 | 0.32 | 0.19 | 0.61 | 0.066 | 0.27 | 48.9 | 38 | 27.4 | 4.51 | 0.050 | 0.940 | 0.061 | 11.7 | 44.0 |
| 501 | 5 | 4 | 10 | 3 | 19 | 0.28 | 0.15 | 0.48 | 0.062 | 0.19 | 37.4 | 15 | 17.3 | 2.21 | 0.055 | 0.332 | 0.054 | 7.4 | 37.4 |
| 502 | 5 | 4 | 10 | 3 | 20 | 0.23 | 0.14 | 0.38 | 0.065 | 0.22 | 42.8 | 38 | 17.8 | 2.87 | 0.057 | 0.467 | 0.072 | 9.0 | 32.9 |
| 503 | 5 | 4 | 10 | 3 | 21 | 0.25 | 0.18 | 0.54 | 0.067 | . | 35.8 | 39 | 29.8 | 2.27 | 0.061 | 0.471 | . | . | . |
| 504 | 5 | 4 | 11 | 1 | 1 | 0.26 | 0.23 | 0.72 | 0.055 | 0.14 | 48.9 | 70 | 7.4 | 4.28 | 0.069 | 1.828 | 0.054 | 6.7 | 35.4 |
| 505 | 5 | 4 | 11 | 1 | 2 | 0.34 | 0.29 | 0.50 | 0.063 | 0.13 | 37.1 | 96 | 11.3 | 4.00 | 0.057 | 1.813 | 0.106 | 6.0 | 33.0 |
| 506 | 5 | 4 | 11 | 1 | 3 | 0.30 | 0.28 | 0.53 | 0.052 | 0.16 | 46.8 | 43 | 6.7 | 5.55 | 0.055 | 5.739 | 0.123 | 6.6 | 34.7 |
| 507 | 5 | 4 | 11 | 1 | 4 | 0.33 | 0.24 | 0.56 | 0.046 | 0.18 | 49.4 | 88 | 13.1 | 6.38 | 0.076 | 4.789 | 0.041 | 7.4 | 30.9 |
| 508 | 5 | 4 | 11 | 1 | 5 | 0.40 | 0.26 | 0.41 | 0.051 | 0.16 | 54.7 | 86 | 13.9 | 4.79 | 0.068 | 5.946 | 0.072 | 5.6 | 31.3 |
| 509 | 5 | 4 | 11 | 1 | 6 | 0.36 | 0.23 | 0.49 | 0.048 | . | 44.7 | 57 | 7.2 | 5.17 | 0.067 | 5.162 | . | . | . |
| 510 | 5 | 4 | 11 | 2 | 7 | 0.37 | 0.25 | 0.58 | 0.056 | . | 71.0 | 48 | 12.0 | 3.27 | 0.064 | 5.119 | . | . | . |
| 511 | 5 | 4 | 11 | 2 | 8 | 0.32 | 0.27 | 0.52 | 0.067 | 0.18 | 55.3 | 65 | 9.1 | 2.48 | 0.049 | 1.504 | 0.083 | 9.5 | 37.7 |
| 512 | 5 | 4 | 11 | 2 | 9 | 0.45 | 0.30 | 0.68 | 0.056 | . | 60.2 | 69 | 13.5 | 5.56 | 0.054 | 1.430 | . | . | . |
| 513 | 5 | 4 | 11 | 2 | 10 | 0.47 | 0.42 | 0.45 | 0.049 | 0.20 | 58.9 | 115 | 15.7 | 3.24 | 0.150 | 6.272 | 0.048 | 9.6 | 35.4 |
| 514 | 5 | 4 | 11 | 2 | 11 | 0.49 | 0.51 | 0.28 | 0.048 | 0.22 | 45.7 | 126 | 12.8 | 3.33 | 0.080 | 1.366 | 0.045 | 8.2 | 28.7 |
| 515 | 5 | 4 | 11 | 2 | 12 | 0.47 | 0.39 | 0.30 | 0.053 | . | 43.8 | 109 | 9.4 | 3.46 | 0.086 | 2.174 | . | . | . |
| 516 | 5 | 4 | 11 | 2 | 13 | 0.44 | 0.25 | 0.42 | 0.048 | 0.19 | 49.8 | 51 | 12.7 | 4.17 | 0.064 | 5.836 | 0.047 | 6.6 | 34.7 |
| 517 | 5 | 4 | 11 | 2 | 14 | 0.39 | 0.23 | 0.57 | 0.049 | 0.20 | 53.1 | 46 | 15.2 | 4.96 | 0.092 | 5.164 | 0.044 | 7.0 | 30.3 |
| 518 | 5 | 4 | 11 | 2 | 15 | 0.40 | 0.28 | 0.50 | 0.044 | . | 49.3 | 59 | 19.0 | 3.94 | 0.087 | 1.820 | . | . | . |
| 519 | 5 | 4 | 11 | 3 | 16 | 0.35 | 0.17 | 0.57 | 0.058 | 0.19 | 45.2 | 13 | 6.0 | 3.80 | 0.037 | 2.211 | 0.054 | 8.2 | 40.3 |
| 520 | 5 | 4 | 11 | 3 | 17 | 0.32 | 0.18 | 0.64 | 0.059 | 0.21 | 42.7 | 55 | 7.0 | 3.88 | 0.038 | 5.549 | 0.099 | 9.9 | 39.6 |
| 521 | 5 | 4 | 11 | 3 | 18 | 0.31 | 0.20 | 0.52 | 0.048 | 0.20 | 40.0 | 47 | 12.3 | 3.79 | 0.092 | 1.701 | 0.073 | 8.7 | 36.7 |
| 522 | 5 | 4 | 11 | 3 | 19 | 0.29 | 0.23 | 0.39 | 0.049 | 0.13 | 29.9 | 72 | 6.8 | 3.50 | 0.029 | 1.943 | 0.054 | 6.9 | 45.4 |
| 523 | 5 | 4 | 11 | 3 | 20 | 0.48 | 0.25 | 0.50 | 0.061 | 0.10 | 39.8 | 38 | 10.7 | 4.43 | 0.053 | 4.254 | 0.078 | 8.3 | 40.0 |
| 524 | 5 | 4 | 11 | 3 | 21 | 0.44 | 0.19 | 0.41 | 0.047 | . | 32.5 | 33 | 8.6 | 3.10 | 0.035 | 4.769 | . | . | . |
| 525 | 5 | 4 | 12 | 1 | 1 | 0.30 | 0.19 | 0.69 | 0.074 | 0.11 | 63.5 | 51 | 11.3 | 3.74 | 0.076 | 1.961 | 0.061 | 7.4 | 35.8 |
| 526 | 5 | 4 | 12 | 1 | 2 | 0.38 | 0.26 | 0.58 | 0.047 | 0.15 | 45.3 | 86 | 16.2 | 4.68 | 0.066 | 0.809 | 0.061 | 7.4 | 32.4 |
| 527 | 5 | 4 | 12 | 1 | 3 | 0.34 | 0.23 | 0.76 | 0.052 | 0.17 | 46.7 | 61 | 15.3 | 16.57 | 0.072 | 0.733 | 0.089 | 7.2 | 34.7 |
| 528 | 5 | 4 | 12 | 1 | 4 | 0.38 | 0.21 | 0.54 | 0.035 | 0.16 | 54.0 | 57 | 18.4 | 2.08 | 0.080 | 3.710 | 0.096 | 7.6 | 32.1 |
| 529 | 5 | 4 | 12 | 1 | 5 | 0.38 | 0.32 | 0.34 | 0.047 | 0.20 | 36.7 | 129 | 10.3 | 2.58 | 0.097 | 0.788 | 0.089 | 9.1 | 38.3 |
| 530 | 5 | 4 | 12 | 1 | 6 | 0.39 | 0.24 | 0.59 | 0.024 | . | 48.5 | 48 | 17.0 | 1.91 | 0.058 | 0.753 | . | . | . |
| 531 | 5 | 4 | 12 | 2 | 7 | 0.51 | 0.28 | 0.72 | 0.057 | 0.22 | 92.0 | 44 | 22.5 | 3.55 | 0.072 | 0.721 | 0.089 | 9.0 | 40.1 |
| 532 | 5 | 4 | 12 | 2 | 8 | 0.39 | 0.27 | 0.56 | 0.031 | 0.23 | 56.6 | 57 | 18.3 | 2.66 | 0.050 | 3.945 | 0.055 | 11.1 | 47.2 |
| 533 | 5 | 4 | 12 | 2 | 9 | 0.42 | 0.25 | 0.57 | 0.056 | . | 70.8 | 43 | 19.7 | 8.79 | 0.059 | 1.250 | . | . | . |
| 534 | 5 | 4 | 12 | 2 | 10 | 0.33 | 0.24 | 0.72 | 0.049 | . | 46.0 | 91 | 14.4 | 3.76 | 0.057 | 3.629 | . | . | . |
| 535 | 5 | 4 | 12 | 2 | 11 | 0.47 | 0.40 | 0.23 | 0.059 | 0.10 | 39.6 | 114 | 41.7 | 3.39 | 0.072 | 4.932 | 0.095 | 7.5 | 38.2 |
| 536 | 5 | 4 | 12 | 2 | 12 | 0.46 | 0.37 | 0.24 | 0.074 | . | 37.2 | 61 | 17.3 | 2.70 | 0.051 | 0.977 | . | . | . |
| 537 | 5 | 4 | 12 | 2 | 13 | 0.33 | 0.19 | 0.62 | 0.056 | 0.21 | 39.6 | 25 | 18.1 | 3.96 | 0.091 | 4.064 | 0.054 | 6.1 | 34.6 |
| 538 | 5 | 4 | 12 | 2 | 14 | 0.35 | 0.22 | 0.66 | 0.026 | 0.16 | 31.3 | 35 | 21.1 | 2.18 | 0.105 | 3.790 | 0.105 | 6.7 | 34.7 |
| 539 | 5 | 4 | 12 | 2 | 15 | 0.38 | 0.20 | 0.85 | 0.028 | . | 30.8 | 47 | 16.5 | 7.04 | 0.121 | 0.771 | . | . | . |

| OBS | SAM | YR | MTH | TR | OB | CA | MG | K | NA | P | FE | MN | ZN | CU | CO | MO | SE | CP | IVOMD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 540 | 5 | 4 | 12 | 3 | 16 | 0.48 | 0.36 | 0.23 | 0.075 | 0.18 | 35.1 | 61 | 9.7 | 2.57 | 0.082 | 1.006 | 0.041 | 6.9 | 35.5 |
| 541 | 5 | 4 | 12 | 3 | 17 | 0.44 | 0.34 | 0.32 | 0.051 | 0.20 | 42.6 | 79 | 8.6 | 2.67 | 0.055 | 1.259 | 0.067 | 12.0 | 48.3 |
| 542 | 5 | 4 | 12 | 3 | 18 | 0.36 | 0.29 | 0.64 | 0.026 | 0.19 | 40.0 | 112 | 13.6 | 2.28 | 0.100 | 1.013 | 0.072 | 10.8 | 36.4 |
| 543 | 5 | 4 | 12 | 3 | 19 | 0.43 | 0.22 | 0.59 | 0.028 | 0.20 | 49.6 | 67 | 21.0 | 3.19 | 0.130 | 0.653 | 0.034 | 6.8 | 34.8 |
| 544 | 5 | 4 | 12 | 3 | 20 | 0.39 | 0.19 | 0.63 | 0.026 | 0.19 | 40.9 | 49 | 18.5 | 4.45 | 0.125 | 5.855 | 0.084 | 7.8 | 36.5 |
| 545 | 5 | 4 | 12 | 3 | 21 | 0.45 | 0.23 | 0.59 | 0.056 | . | 39.5 | 54 | 18.0 | 1.57 | 0.103 | 3.853 | . | . | . |

## LITERATURE CITED


Ammerman, C.B. 1970. Recent developments in cobalt and copper in ruminant nutrition. A review. J. Dairy Sci. 53:1097.

Ammerman, C.B. 1981. Cobalt. ANH Mineral Series. Animal Nutrition and Health, October, pp. 26-28.

Ammerman, C.B., J.M. Loaiza, W.G. Blue. J.F. Gamble and G.F. Martin. 1974. Mineral composition of tissue from beef cattle under grazing conditions in Panama. J. Anim. Sci. 38:155.

Ammerman, C.B., S.M. Miller and and L.R. McDowell. 1978. Selenium in ruminant nutrition. In: J.H. Conrad and L. R. McDowell (Eds.). Latin American Symposium on Mineral Research with Grazing Ruminants. Univ. of Florida, Gainesville.

Anderson, A.K., H.E. Gayley and A.D. Pratt. 1930. Studies on the chemical composition of bovine blood. J.Dairy Sci. 13:336.

Andrews, E.D., W.J. Hartley and A. B. Grant. 1968. Selenium-responsive diseases of animals in New Zealand. N. Z. Vet. J. 16:3.

Annison, E.F. and D. Lewis. 1959. Metabolism in the Rumen. p. 135. John Wiley and Sons, New York.

Agricultural Research Council (ARC). 1965. The Nutrient Requirement of Farm Livestock. 2. Ruminants. Agricultural Research Counsil, London.

Agricultural Research Council (ARC). 1980. The Nutrient Requirements of Ruminant Livestock. Agricultural Research Council. The Greshman Press, Old Working Surrey.

Bahia, V.G. 1978. Techniques of soil sampling and analysis. In: J.H. Conrad and L.R. McDowell (Eds.). Latin America Symposium on Mineral Nutrition Research with Grazing Ruminants. pp. 27-29. Univ. of Florida, Gainesville.

Bauer, B., E. Galdo, L.R. McDowell, M. Koger, J.K. Loosly and J.H. Conrad. 1982. Mineral status of cattle in tropical lowlands of Bolivia. In: J.M. Gawthorne, J.M. Jowell, C.L. White. (Eds.) Trace Element Metabolism in Man and Animals. Berlin, Springer. p.50-53.

Becker, R.B., J.R. Henderson, and R.B. Leighty. 1965. Mineral malnutrition in cattle. Fla. Agr. Exp. Sta. Bull. 699.

Becker, R.B., W.M. Neal and A.L. Shealy. 1933. Stiffs or Sweeny (phosphorus deficiency) in cattle. Univ. of Florida Agr. Exp. Sta. Bull. No. 264.

Blaxter, K.L. and G.A.M. Sharman. 1955. Hypomagnesaemic tetany in beef cattle. Vet. Rec. 67:108.

Boyazoglu, P.A., L.E. Barret, E. Young and H. Ebedes. 1972. Liver mineral analysis as an indicator of nutritional adequacy. Second World Congress of Animal Feeding, Madrid.

Brady, N.C. 1984. The Nature and Properties of Soils (9th Ed.). Mcmillan Publishing Co., New York.

Braithwaite, G.D. 1978. The effect of 1-hydroxycholecalciferol on calcium and phosphorus metabolism in the lactating ewe. Br. J. Nutr. 40: 387.

Braithwaite, G.D. 1984. Changes in phosphorus metabolism of sheep in response to the increased demands of phosphorus associated with and intravenous infusion of calcium. J. Agr. Sci., Camb. 102:135.

Braithwaite. G.D. 1985. Endogenous fecal loss of phosphorus in growing lambs and the calculation of phosphorus requirements. J.Agri. Sci., Camb. 105:67.

Braithwaite, G.D. 1986. Phosphorus requirements for ewes in pregnancy and lactation. J. Agr. Sci., Camb. 106:271-278.

Breland, H.L. 1976. Memorandum to Florida extension specialists and county extension directors. IFAS Soil Science Lab, University of Florida, Gainesville.

Burdin, M.L., and D.A. Howard. 1963. A blood preservation and anticoagulant for inorganic phosphate and other determinations. Vet. Rec. 75:494.

Butcher, J.E., J.W. Call, J.T. Blake and J.L. Shupe. 1979. Dietary phosphorus levels can cause problems in beef cows. J. Anim. Sci. 49 (Supl.1):359 (Abstr.).

Butcher, J.E., J.W. Call, J.T. Blake, J.L. Chupe and A.F. Olson. 1982. Phosphorus influence on reproduction in beef cattle. J. Ani. Sci. 55:412 (Abstr.).

Butterworth, M.H. 1985. Beef Cattle Nutrition and Tropical Pasture. Longman Co., London.

Call, J.W., J.E. Butcher, J.L. Shupe, J.T. Blake and A.E. Olson. 1986. Dietary Phosphorus for beef cows. Am. J. Vet. Res. 47:475.

Call, J.W., J.E. Butcher, J.L. Shupe, R.C. Lamb, R.L. Boman and A.E. Olson. 1987. Clinical effects of low dietary phosphorus concentrations in feed given to lactating dairy cows. Am. J. Vet. Res. 48:133.

Call, J.W., J.E. Butcher, J.T. Blake, R.A. Smart and J.L. Shupe. 1978. Phosphorus influence on growth and reproduction of beef cattle. J. Anim. Sci. 47:216.

Cary, E.E., G.A. Wieczorak and W.H. Allaway. 1967. Reactions of selenite Se added to soils that produce low-Se forages. Soil Sci.Soc. Am. Proc. 31:22.

Challa, J., G.D. Braithwaite and M.S. Shanoa. 1989. Phosphorus homoeostasis in growing calves. J. Agri. Sci., Camb. 112:217.

Chicco, C.F., C.B. Ammerman, J.P. Feaster and B.G. Dunavant. 1973. Nutritional interrelationship of dietary calcium, phosphorus and magnesium in sheep. J. Anim. Sci. 36:986.

Church, D.C. 1971. Digestive Physiology and Nutrition of Ruminants Vol. 2, Nutrition D.C. Church, Corvallis, OR.

Clanton, D.C. 1980. Applied potassium nutrition in beef cattle. Animal Health and Nutrition Bulletin MB - 17. International Minerals and Chemical Corporation, Mundelin, Illinois.

Claypool, D.W., F.W. Adams, H.W. Pendell, N.A. Hartman, Jr and J.F. Bone. 1975. Relationship between the level of Cu in the blood plasma and liver of cattle. J. Anim. Sci. 41:911.

Cohen, R.D.H. 1973. Phosphorus nutrition of beef cattle. 3. Effect of supplementation on the phosphorus content of blood and on the phosphorus and calcium contents of hair and bone of grazing steers. Australian J. Exp. Agr. Ani. Husb. 13:625.

Cohen, R.D.H. 1980. Phosphorus in rangeland ruminant nutrition: A review. Livestock Prod. Sci. 7:25-37.

Cohen, R.D.H. 1987. Supplementation practices of grazing livestock - macrominerals. In: Proceedings, Grazing Livestock Nutrition Conference. pp. 93-100. University of Wyoming. Jackson, Wyoming.

Conrad, J.H. 1978. Soil, plant and animal tissue as predictors of the mineral status of ruminants. In: J.H. Conrad and L.R. McDowell (Eds.) Latin American Symposium on Mineral Nutrition Research with Grazing Ruminants. pp. 143.

Conrad, J.H., J.C. Sousa, M.O. Mendes, W,G, Blue and L.R. McDowell. 1980. Iron, manganese, sodium and zinc interrelationships in a tropical soil, plant and animal system. In:L.S. Verde and A. Fernandez (Eds.) Proc. Fourth World Conference on Animal Production. pp. 38 -53. Buenos Aires, Argentina.

Cooper, W.C., K.G. Bennet and F.C. Croxton. 1974. The history, occurrence, and properties of selenium. In: Selenium. R.A. Zingaro and W.C. Cooper (Eds.). Van Nostrand Reinhold Company, New York. pp.1-30.

Cunha, T.J., R.L. Shirley, H.L.Chapman, C.B. Ammerman, G.K. Davis, W.G. Kirk and J.F.Hentges. 1964. Minerals for beef cattle in Florida. Florida Agr. Exp. Sta. Bull. 683.

De Luca, H.F. and M.K. Schnoes. 1976. Metabolism and mechanism of action of vitamin D. Ann. Rev. Biochem. 45:631.

De Sousa, J.C. 1978. Interrelationships among mineral levels in soil, forage and animal tissues on ranches in northern Mato Grosso, Brazil. Ph.D. Dissertation, University of Florida.

Duble, R.L., J.A. Lancaster and E.C. Holt. 1971. Forage characteristics limiting animal performance on warm -season perennial grasses. Agronomy J. 63:795.

Dudal, R. 1977. Plant nutrient relationship in major soil regions. In: Proceedings of International Seminar on Soil Environment and Fertility Management in Intensive Agriculture. Tokyo, Japan. pp. 78-92.

Durand, M. and R. Kawashima. 1980. Influence of minerals in rumen microbial digestion. In: Digestive Physiology and Metabolism. in ruminants. Y. Ruckebusch and P. Trivend (Eds.). AVI Publishing Co. Inc., Westpoint, CT.

Eckles, C.H., L.S. Palmer, T.W. Guillickson, C.P. Fitch, W.L. Boid, L. Bishop and J.W. Nelson. 1935. Effects of uncomplicated phosphorus deficiency on estrus cycle, reproduction and composition of tissue of mature dairy cows. Cornell Vet. 25:22.

Egan, A.R. 1975. Diagnosis of trace element deficiencies. In: D.J.D. Nicholas and A.R. Eagan (Eds.) Trace Elements in Soil-Plant-Animal Systems. pp. 371-384. Academic Press, Inc., New York.

Engels, E.A.N. 1981. Mineral status and profiles (blood, bone and milk) of the grazing ruminant with special reference to calcium , phosphorus and magnesium. S.Afr. J. Anim. Sci. 11:171.

Field, A.C. 1981. Some thoughts on dietary requirements of macro-elements for ruminants. Proc. Nutr. Soc. 40:267.

Fick, K.R., L.R. McDowell, P.H. Miles, N.S. Wilkinson, J.D. Funk and J.H. Conrad. 1979. Methods of Mineral Analysis for Plant and Animal Tissues (2nd Ed.). Dept. Anim. Sci., Univ. of Florida, Gainesville.

Fiskell, J.G.A. 1970. Cation-exchange capacity and component variations of soils of southeastern USA. Soil Sci. Soc. Am. Proc. 34:723.

Fiskell, J.G.A. and L.W. Zelazny. 1972. Acid properties of some Florida soils. I. pH-dependent cation exchange. Soil and Crop Science Society of Florida Proceedings 31:145.

Forar, F.L., R.L. Kincaid, R.L. Preston and J.K. Hillers. 1982. Variation of inorganic phosphorus in blood plasma and milk of lactating cows. J. Dairy Sci., 65:760.

Gallaher, R.N., C.O. Welldon and J.G. Futral. 1975. An aluminum block digester for plant and soil analysis. Soil Sci. Soc. Amer. Proc. 39:803-806.

Gammon, N.,Jr. 1957. The behavior of potassium and potassium fertilizer in Florida soils. Soil Crop Sci. Soc. Florida Proc. 17:156.

Ganther, H.E. 1974. Biochemistry of selenium. In: Selenium. R.A. Zingaro and W.C. Cooper (Eds.). Van Nostrand Reinhold Co., New York. pp. 546-614.

Gartnet, R.J.W., J.W. Ryley and A.W. Beatie. 1965. The influence of degree of excitation on certain blood constituents in beef cattle. Aust. J. Exp. Biol. Med. Sci. 43:713.

Gomide, J.A. 1978. Mineral composition of grasses and tropical leguminous forage. In: J.H. Conrad and L.R. McDowell (Ed.) Latin American Symposium on Mineral Nutrition with Grazing Ruminants. pp. 32-40. Univ. of Florida, Gainesville.

Grace, N.D., M.J. Ulyatt and J.C. MacRae. 1974. Quantitative digestion of fresh herbage by sheep. 3. Movement of Mg, Ca, P,K and Na in digestive tract. J.Agr. Sci. 82:321.

Grimme, H. 1976. Soil factors of potassium availability. Bull. Indian Soc. Soil Sci., 10:19.

Grizzle, J.E., C.F. Starmer and G.G. Koch. 1969. Analysis of categorical data by linear models. Biometrics, 25: 489.

Guyton, A.C. 1966. Parathyroid hormone, calcium and phosphate metabolism, vitamin D, bone and teeth. In: Textbook of Medical Physiology (3rd Ed.). pp. 1100-1118. W.B. Saunders Co., Philadelphia.

Hallberg, L. 1984. Iron. In: Present Knowledge in Nutrition (5th Ed.) pp. 459-478. The Nutrition Foundation, Inc., Washington, DC.

Harris, W. P. and P. Popat. 1954. Determination of the phosphorus content of lipids. J. Am. Oil Chem. Soc. 31:124.

Harrison, H.E. 1984. Phosphorus. In: Present Knowledge in Nutrition (5th Ed.). pp. 413-421. The Nutrition Foundation Inc., Washington.

Hartley, W. J., J. Mullins and S. M. Lawson. 1959. Nutritional siderosis in the bivine. New Zeland Vet. J. 7:99.

Hartmans, J. 1974. Tracing and treating mineral disorders in cattle under field conditions. In: W.G. Hoekstra, J.W. Suttie, H.E. Ganther and W. Mertz (Eds.) Trace Element Metabolism in Animals - 2. pp. 261-273. University Park Press, Baltimore, Maryland.

Hidiroglou, M., R.B. Carson and G.A. Brossard. 1965. Influence of selenium on the selenium contents of hair and on the incidence of nutritional muscular disease in beef cattle. Can. J. Anim. Sci. 45:187.

Hignett, S.L. and P.G. Hignett. 1952. The influence of nutrition on reproductive efficiency on cattle. (II). The effect of the phosphorus intake on ovarian activity and fertility of heifers. Vet. Rec. 64:203.

Holzochuh, W., A. Dittrich and S. Legal. 1971. Effect of different amounts of phosphorus for pregnant heifers on physiological values in their progeny. Nutr. Abstr. and Rev. 41:752.

Horowitz, A. and H.S. Dantas. 1973. The Geochemistry of minor elemnts in Pernambuco soils. III. Copper in the zone Litoral Meta. Pesq. Agropec. Brs. Ser. Agron. 8:169.

Houser, R.H., K.R. Fick and L.R. McDowell. 1978. Cobalt in ruminant nutrition. In: J.H. Conrad and L.R. McDowell (Eds.), p. 89-93. Latin American Symposium on Mineral Nutrition Research with Grazing Ruminants. Univ. of Florida, Gainesville.

Hungate, R.E. 1966. The Rumen and its Microbes. Academic Press, New York.

Irving, J.T. 1964. Dynamics and functions of phosphorus. In: C.L. Comar and F. Bronner (Eds.) Mineral Metabolism, Vol. 2, Part a. pp. 249-313. Academic Press, New York.

Irving, J.T. 1973. Calcium and Phosphorus Metabolism. Academic Press, New York.

Jarrel-Ash Division. 1982. Jarrel-Ash ICAP-9000 Plasma Spectrphotometer Operator's manual. Jarrel-Ash Division, Fisher Scientific Co., Franklin, MA.

Jones, J.B. Jr. 1972. Plant tissue analysis for micronutrients. In: Micronutrients in Agriculture. J.J. Mortvedt, P.M. Giordano and W. L. Lindsay (Eds.). Soil Science Society of America, Inc., Madison, Wisconsin,

p.319.

Jubb, T.F. and K.F. Crough. 1988. Phosphorus supplementation of cattle. Aust. Vet. J. 65:264.

Judkins, M.B., J.P. Wallace, E.E. Parker and J.D. Wright. 1985. Performance and phosphorus status of range cows with and without phosphorus supplementation. J. Range Manage. 38:139.

Karlen, D.L., R. Ellis, Jr., D.A. Whitney, and D.L. Grunes. 1980. Soil and plant parameters associated with grass tetany of cattle in Kansas. Agron. J., 72:61.

Kiatoko, M. 1979. Evaluating the Mineral Status of Beef Cattle Herds From Four Soil Order Regions of Florida. Ph. D. Dissertation. Univ. of Florida, Gainesville.

Kiatoko, M., L.R. McDowell, J.E. Bertrand, H.C. Chapman, F. M. Pate, F. G. Martin and J. H. Conrad. 1982. Evaluating the nutritional status of beef cattle herds from four soil order regions of Florida. I. Macroelements, protein, carotene, vitamins A and E, hemoglobin and hematocrit. J. Anim. Sci. 55:28.

Kincaid, R.L., C.C. Gay and R.I. Krieger. 1986. Relationship of serum and plasma ceruloplasmin concentrations of cattle and the effects of whole blood sample storage. Am.J. Vet. Res. 47:1157.

Kleiber, M.H., H.Goss and H.R. Gilbert. 1936. Phosphorus deficiency metabolism and food utilization in beef heifers. J. Nutr. 12:121-131.

Kubota, J., V.A. Laser, G.H. Simonson and W.W. Hill. 1967. The relationship of soil to Mo toxicity in grazing animals in Oregon. Soil Sci. Amer. Proc. 31:667.

Lane, A.G. J.R. Campbell and J.F. Krause. 1968. Blood mineral composition in ruminants. J. Anim. Sci., 27:766.

Langlands, J.P. 1987. Assessing the nutrient status of herbivores. In: J.B. Hacker and J.H. Ternouth (Eds.) The Nutrition of Herbivores. pp. 363-390. Academic Press, Inc. London.

Large, R.L. 1971. Soil Fertility recommendations based on a balance saturation of the CEC. Soil Sci. Plant Anal. 2:109.

Lassiter, J.W. and H.M. Edwards, Jr. 1982. Animal Nutrition.

Reston Publishing Co. Inc. Reston, Virginia.

Leeper, G.W. 1947. The forms and reactions of manganese in soils. Soil Sci. 63:79.

Lehninger, A.L. 1982. Principles of Biochemistry. Worth Publishers, Inc., New York.

Little, D.A. 1972. Bone biopsy in cattle and sheep for studies of phosphorus status. Australian Vet. J. 48:668.

Little, D.A. 1980. Observations on the phosphorus requirement of cattle for growth. Res. Vet. Sci. 28:258.

Little, D.A. 1984. Definition of an objective criterion of body phosphorus reserves in cattle and its evaluation in vivo. Can. J. Anim. Sci. 64:229-231

Marion, V.P.R. and E.A.N. Engels. 1985 Phosphorus and the grazing ruminant 2. The effects of supplementary P on cattle at Glen and Armoedsvlakte. S. Afr. J Anim. Sci. 16: 1.

Mayland, H.F., T.R. Kramer and W.T. Johnson. 1987. Trace elements in the nutrition and immunological response of grazing livestock. In: Grazing Livestock Nutrition Conference. Proc., Univ. of Wyoming. Jackson, Wyoming.

Mayland, H.F., R.C. Rosenau and A. R. Florence. 1980. Grazing cow and calf responses to zinc supplementation. J. Anim. Sci. 51:96.

Maynard, L.A., J.K. Loosli, H.F. Hintz and R.G. Warner. 1979. Animal Nutrition (7th Ed.). McGraw-Hill Book Co., New York.

McDonald, I.W. 1968. The nutrition of grazing ruminants. Nutr. Abstr. and Rev. 38:381.

McDonald, P., R.A. Edwards and J.F.D. Greenhalgh. 1981. Animal Nutrition (3rd Ed.). Longman Inc., New York.

McDowell, L.R. 1976. Mineral deficiencies and toxicities and their effect on beef production in developing countries. In: A.J. Smith (Ed.) Beef Cattle Production in Developing Countries. pp. 216-241. Univ. of Edinburgh, Centre for Tropical Veterinary Medicine.

McDowell, L.R. 1977. Geographical distribution of nutritional diseases in animals. Dept. of Animal

Science. Univ. of Florida, Gainesville.

McDowell, L.R. 1985. Calcium, phosphorus, and fluorine. In: L.R. McDowell (Ed.) Nutrition of Grazing Ruminants in Warm Climates. pp. 189-212. Academic Press, Orlando, Fl.

McDowell, L.R. 1989. Vitamins in Animal Nutrition, Comparative aspects to Human Nutrition. Academic Press, Inc., San Diego, California.

McDowell, L.R. and J.H. Conrad. 1977. Trace mineral nutrition in Latin America. World Anim. Rev. 24:24-33.

McDowell, L.R., J.H. Conrad and G.L. Ellis. 1984. Mineral deficiencies and imbalances and their diagnosis. In: F.M.C. Gilchrist and R.I. Mackie (Eds.) Symposium on Herbivore Nutrition in Sub tropics and Tropics. pp. 67-88. Univ. of Pretoria, Pretoria, South Africa.

McDowell, L.R., J.H. Conrad and G.L. Ellis. 1986. Mineral imbalances and their diagnosis in ruminant. In: Nuclear and Related Techniques in Animal Production and Health. pp. 521-534. International Atomic Energy Agency, Vienna, Austria.

McDowell, R.L., J.H. Conrad, G.L. Ellis and J.K. Loosli. 1983. Minerals for grazing ruminants in tropical regions. Extension Bulletin, Department of Animal Science, University of Florida, Gainesville.

McDowell, L.R., R.H. Houser and K.R. Fick. 1978. Iron, zinc and manganese in ruminant nutrition. p. 108-120. In: J.H. Conrad and L.R. McDowell (Eds.), Latin America Symposium on Mineral Research with Grazing Ruminants. University of Florida, Gainesville.

McDowell, L.R., M. Kiatoko, J.E. Bertrand, H.L. Chapman. F.M. Pate, F.G. Martin and J.H. Conrad. 1982. Evaluating the nutritional status of beef cattle from four soil order regions of Florida. II. Trace minerals. J. Anim. Sci. 55:38-47.

McDowell, L.R., M. Kiatoko, C.E. Lang, H.A. Fonseca, E. Vargas, J.K. Loosli and J.H. Conrad. 1980. Latin American Mineral Research - Costa Rica. p. 39-47. In: L.S. Verde, and A. Fernandez (Eds.), IV World Conference on Animal Production. Buenos Aires.

McDowell, L.R., Y. Salih, J.F. Hentges, R.M. Mason, Jr. and J.C. Wilcox. 1989. Effect of mineral supplementation on tissue mineral concentrations of grazing Brahman cattle. I. Microelements. Trop. Anim. Prod. (submited).

McDowell, L.R., Y. Salih, J.F. Hentges, R.M. Mason, Jr. and J.C. Wilcox. 1989. Effect of mineral supplementation on tissue mineral concentrations of grazing Brahman cattle. II. Trace Minerals. Int. J. of Anim. Sci. 4:6-13.

McLaren, R.G., J.G. Williams and R.S. Swift. 1983. Some observations on the resorption and distribution behavior of copper with soil components. J. Soil Sci. 34:325-331.

Melvin, J.S. 1984. Duke's Physiology of Domestic Animals. 10th ed. Ithaca, NY, Comstock Publishing Associates, Cornell University Press.

Mendes, M.O. 1977. Mineral Status of Beef Cattle in Northern Part of Mato Grosso, Brazil, as indicated by Age, Season and Sampling Technique. Ph.D. Dissertation. Univ. of Florida, Gainesville.

Merkel, R. 1989. Mineral Status Comparisons Between Water Buffalo and Charolais Cattle in Florida. M. S. Thesis. Univ. of Florida, Gainesville.

Merkel, R.C, L.R. McDowell, H.L. Popenoe and N.S. Wilkinson. 1990. Comparison of the mineral content of milk and calf serum from buffalo and Charolais cattle. J.Dairy Sci. (In press).

Miles, W.H. and L.R. McDowell. 1983. Mineral deficiencies in the llanos rangelands of Colombia. World Anim. Rev. 46:2-10.

Miller, W.J. 1983. Phosphorus-ruminant-nutritional requirements, biochemistry and metabolism. In: National Feed Ingredient Association's (NFIA) Mineral Ingredient Handbook. pp. 1-14. NFIA, West Des Moines, IA.

Miller, W.J. and P.E. Stake. 1974. Uses and limitations of biochemical measurements in diagnosing mineral deficiencies. Proc. Georgia Nutr. Conf. for Feed Industry. 25.

Mills, C.F., A.C. Dalgarno, R.B. Williams and J. Quarterman. 1967. Zinc deficiency and zinc requirement of calves and lambs. Brit. J. Nutr. 21:751.

Minson,D.J. 1971. The nutritive value of tropical pastures. J. Australian Inst. Agri. Sci. 37:255.

Moore,J.E.,and G.O. Mott. 1974. Recovery of residual organic matter from an in vitro digestion in forages. J. Dairy Sci. 57:1258.

Mooso, G.D. 1982. Warm-season Grass Production and Nutritive Uptake with Liquid and Solid N-P-K Fertilizers. M.S. Thesis, Brigham Young Univ.

Morrison, F.B. 1956. Feeds and Feeding. Morrison Publishing Co., Ithaca, NY.

Mylrea, P.J. and R.F. Bayfield. 1968. Concentration of some components in blood and serum of apparently healthy dairy cattle. Aust. Vet. J. 44:565.

NCMN. 1973. Tracing and Treating Mineral Disorders in Dairy Cattle. Committee on Mineral Nutrition, Center for Agriculture Publishing and Documentation, Wageningen, Netherlands.

Newton, G.L., J.P. Fontenot, R.E. Turker and C.E. Poland. 1972. Effect of high dietary potassium intake on the metabolism of magnesium by sheep. J.Anim. Sci. 35:440.

Nielsen, F.H. and W. Mertz. 1984. Other trace elements. In:Present Knowledge in Nutrition (5th Ed.). The Nutrition Foundation, Inc., Washington, D.C.

NRC. 1976. Nutrient requirements by domestic animals., No. 4. Nutrient Requirements of Beef Cattle, Fifth Edition. National Academy of Science, Washington. D.C.

NRC. 1980. Mineral Tolerances of Domestic Animals. National Academy of Sciences, National Research Council, Washington, D.C.

NRC. 1984. Nutrient Requirments of Domestic Animals, No 4. Nutrient Requirement of Beef Cattle (6th Rev. Ed.). National Academy of Science, National Research Council. Washington, DC.

NRC. 1989. Nutrient Requirements of Domestic Animals. Nutrient Requirements of Dairy Cattle (6th Rev. Ed.). National Research Council. National Academy Press. Washington, D.C.

O'Dell, B.L. 1984. Copper. In: Present Knowledge in Nutrition (5th Ed.). The Nutrition Fundation, Inc.

Washington, D.C.

Olsen, S.R. 1972. Micronutrient interactions. In: Micronutrients in Agriculture. J.C. Mortvedt, P.M. Giordano and W.L. Lindsay (Eds.). p. 243-264. Soil Sci. Soc. of America, Inc., Madison, Wisconsin.

Paynter, D.I. 1982. Differences between serum and plasma ceruloplasmin activities and copper concentrations: Investigation of possible contributing factors. Aust. J. Biol. Sci. 35:353.

Palmer, L.S., T.W. Gullickson, W.L. Boyd, C.P. Fitch and J.W. Nelson. 1941. The effect on rations deficient in phosphorus and protein on ovulation, estrus and reproduction in dairy heifers. J. Dairy Sci. 24:199.

Perge, P., H. Hardebeck, H. Sommer and E. Pfeffer. 1983. Investigations into the effect of the feed on calcium and phosphorus contents in the blood serum and saliva of wethers. Ani. Res. Dev. 17:7.

Perkin-Elmer Corp. 1980. Analytical Methods for Atomic Absorption Spectrophotometry. Author, Norwalk, CT.

Perkin-Elmer Corp. 1984. Analytical Methods for Furnace Atomic Absorption Spectrometry. Perkin-Elmer, Norwalk, CT.

Perry, T.W., W.M. Beeson, W.H. Smith and M.T. Mohler. 1976. Effect of supplemental selenium on performance and deposit of selenium in blood and hair of finishing cattle. J. Anim. Sci. 42:192.

Pope, A.L., R.J. Moir, M. Somers, E.J. Underwood and C. L. White. 1979. The effect of sulfur on $^{75}Se$ absorption and retention in sheep. J. Nutr. 109:1448.

Popenoe, H. 1960. Effects of shifting cultivation on natural soils constituents in Central America. Ph.D. Dissertation. Univ. of Florida, Gainesville.

Pott, E.B., R.R. Tulio, I.L. De Almeida, P.A.L. De Brum and J.L. De Sousa. 1987. Desempenho reprodutivo de bovinos na sub-regiao dos Paiaguas do Pantanal Mato -grossense. II. Efeito da suplementacao mineral sobre indices reprodutivos de novilhas. Pesq. agropec. bras., Brasilia, Brasil. 22:1265.

Powell, G.W., W. J. Miller, J.D. Morton and C.M. Clayton. 1964. Influence of dietary calcium and supplemental Zn on Cd toxicity in the bovine. J. Nutr. 84:205.

Preston, R.L. 1976. Phosphorus in beef cattle and sheep nutrition In: NFIA Literature Review in Phosphorus in Ruminant Nutrition. pp. 1-44. National Feed Ingredient's Association, West Des Moines, IA.

Read, M.V.P., E.A.N. Engels and W.A. Smith. 1986. Phosphorus and the grazing ruminant. 3. Rib bone samples as an indication of the status of cattle. S. Afr. J. Anim. Sci. 16:13.

Reid, R.L. and D.J. Horvath. 1980. Soil chemistry and mineral problems in farm livestock: A review. Animal Feed Sci. Technol. 5:95.

Reinhardt, T.A., L.R. Horst and J.P. Goff. 1988. Calcium, phosphorus and magnesium homeostasis in ruminants. The Veterinary Clinic of North America. Food Animal Practice. 4:331.

Rhue, E.D. and G.Kidder. 1983. Analytical Procedures used by the IFAS extension soil testing laboratory and the interpretation of results. Soil Sci. Dept., Univ. of Florida, Gainesville.

Rhue, E.D. and J.J. Street. 1980. Potassium: A primary plant nutrient. Soil Sci. Fact Sheet No. SL-34. Univ. of Florida, Gainesville.

Rollison, D.H.L. and R.M. Bredon. 1960. Factors causing alterations of the levels of inorganic phosphorus in the blood of Zebu cattle. J. Agr. Sci. 54:235.

Rosa, I.V., P.R. Henry and C.B. Ammerman. 1982. Interrelationship of dietary phosphorus, aluminum and iron on performance and tissue mineral composition in lambs. J.Anim. Sci. 55:1231.

Salih, Y. 1984. Mineral Status of Brahman beef cattle receiving mineral supplementation in central Florida. Ph.D. Dissertation. University of Florida, Gainesville.

Salih, Y., L.R. McDowell, J.F. Hentges and C.J. Wilcox. 1986. Effect of mineral supplementation of Brahman cows on blood minerals and metabolic profiles in Brahman calves. Nutr. Rep. Inter. 34:357.

Salih, Y., L.R. McDowell, J.F. Hentges, R.M. Mason, Jr. and C.J. Wilcox. 1988. Effect of mineral supplementation of grazing Brahman cattle I. Macrominerals. Int. J. Anim. Sci. 3:195.

Sanchez, P.A. 1976. Properties and management of soils in the tropics. John Wiley and Sons, New York.

Sanchez, P.A. 1981. Suelos del Tropico. Caracteristicas y manejo pp. 226-254. IICA, San Jose, Costa Rica.

SAS Institute Inc. 1987. SAS/STAT Guide for personal computers, Version 6 Edition. SAS Institute Inc., Cary, North Carolina.

Scott, D. and A.F. McLean. 1981. Control of mineral absorption in ruminants. Proceedings of the Nutrition Society 40:257.

Shirley, R.L., M. Koger, H.L. Chapman, Jr., P.E. Loggins, R.W. Kidder and J.F Easley. 1966. Selenium and weaning weights of cattle and sheep. J.Anim. Sci. 25:648.

Short, R.E. and R.A. Bellows. 1971. Relationship among weight gains,age at puberty and reproductive performance in heifers. J.Anim. Sci. 32:127.

Shupe, J.L., J.E. Butcher, J.W. Call, A.E. Olson and J.T. Blake. 1988. Clinical signs and bone changes associated with phosphorus deficiency in beef cattle. Am. J. Vet. Res. 49:1629.

Smith, K.L., J.S. Hogan and H.R. Conrad. 1988. Selenium in dairy cattle: Its role in disease resistance. Vet. Medicine. 83:72.

Snedecor, J.W. and W.G. Cochran. 1980. Statistical Methods (7th Ed.). The Iowa State University Press, Ames.

Spears, J.W. 1989. Zinc methionine for ruminants: relative bioavailability of zinc in lambs and effects of growth and performance of growing heifers J.Anim. Sci. 67:835.

Street, J.J. and R.D. Rhue. 1980. Essential micronutrients: Zinc. Soil Science Fact Sheet No. SL-33. Univ. of Florida, Gainesville.

Technicon Industrial Systems. 1978. Individual/simultaneous determination of crude protein,phosphorus and/or calcium in feeds. Industrial Method No. 605-77A. Tarrytown, New York.

Tejada, R., R.L. McDowell, F.G. Martin and J.H. Conrad. 1987. Evaluation of the macromineral status of cattle in specific regions in Guatemala. Nutrional Reports International. 35:989.

Teleni, E., H. Dean and R.M. Murray. 1976. Some factors affecting the measurement of blood inorganic phosphorus in cattle. Aust.Vet. J. 52:529.

Theiler, A., H.H. Green and P.J. DuToit. 1928. Studies in mineral metabolism (III). Breeding of cattle on phosphorus deficient pasture. J. Agri. Sci. 15:369.

Thomas, F.M. 1974. Phosphorus homeostasis in sheep. II. Influence of diet on the pathway of excretion of phosphorus. Aust. J. Agri. Res. 25:485.

Thomas, F.M., R.J. Moir and M. Somers. 1967. Phosphorus turnover in sheep. Aust.J. Agri. Res. 18:143.

Tilley, J.M.A., and R.A. Terry. 1963. A two-stage technique for the in vitro digestion of forage crops. J. Brit. Grass. Soc. 18:104.

Tisdale, S.L. and W.L. Nelson. 1975. Soil Fertility and Fertilizers. Publ. Co. Inc., New York.

Towers, N.R. and R.G. Clark. 1983. Factors in diagnosing mineral deficiencies. In: The mineral requirements of grazing ruminants. Occasional publication No 9. New Zeland Society of Animal Production.

United States Department of Agriculture, Soil Conservation Service. 1987.Important Native Grasses for Range Conservation in Florida. Gainesville, Florida.

Underwood, E.J. 1966. The mineral Nutrition of Livestock. The Central Press (Aberdeen) Ltd., Great Britain.

Underwood, E.J. 1977. Trace Elements in Human and Animal Nutrition (4th Ed.). Academic Press, New York.

Underwood, E.J. 1981. The Mineral Nutrition of Livestock (2nd Ed.) Commonwealth Agricultural Bureau, London.

Van Nevel, C.J. and D.I. Demeyer. 1977. Determination of rumen microbial growth in vitro from $^{32}$P-labelled phosphate incorporation. Br. J. Nutr., 38:221.

Van Niekerk, B.D.H. 1974. Supplementation of grazing ruminants. Proceedings of the Seminar on Potential to Increase Beef Production in Tropical America, CIAT, Cali, Colombia.

Viets, F.G. and W.L. Lindsay. 1973. Testing soil for zinc, copper, manganese and iron. In L.M. Walsh and J. Beaton (Eds.) Soil Testing and Plant Analysis. pp. 153-172. Soil Sci. Soc. Am. Inc., Madison, WI.

Wagner, T.N., D.E. Ray, C.D. Lox and G. H. Stott. 1973. Effect of stress on serum zinc and plasma corticoids in dairy cattle. J. Dairy Sci. 56:748.

Walling, M.W. 1977. Intestinal inorganic phosphate transport. Adv. Exp. Med. Biol. 103:131.

Ward, G.M. 1978. Molybdenum toxicity and hypocuprosis in ruminants: A review. J.Anim. Sci. 46:1078.

Warncke, D.D. and L.S. Robertson. 1976. Understanding the MSU soil test report: Results and Recommendations. Extension Bulletin 937. MSU AG Facts. Cooperative Extension Service. Michigan State University.

Wasserman, R.H. 1981. Intestinal Absorption of calcium and phosphorus. Fed. Proc. 40:68.

Whetter, P.A. and D.E. Ullrey. 1978. Improved fluorimetric method for determining selenium. J. Assoc. Anal. Chem. 61:927.

Williams, S.N. 1987. Assessing the Phosphorus Status of Growing Beef Heifers. Ph.D. Dissertation. Univ. of Florida, Gainesville.

Williams, S.N., L.R. McDowell, A.C. Warnick, N.S. Wilkinson and L.A. Laurence. 1990. Influence of dietary phosphorus in blood, milk, bone, feces and selected fluids and tissues of growing heifers. J.Dairy Science. (In press).

Winks, L. and A.R. Laing. 1968. Phosphorus and molasses supplements for grazing beef weaners. Nutr. Abstr. and Rev. 38:753.

Wise, M.B., M.B., A. L. Ordoveza and E.R. Barrick. 1963. Influence of variation in dietary calcium:phosphorus ratios on performance and blood constituents of calves. J. Nutr. 79:79.

## BIOGRAPHICAL SKETCH

Juan Edmundo Espinoza was born in Cochabamba, Bolivia, on March 30, 1946. He attended the Universidad Boliviana Mayor de San Simon and graduated with an Agricultural Engineer in 1971. Following graduation the author was employed by the Instituto Boliviano de Tecnologia Agropecuaria (IBTA).

Since then, he has been conducting research on water buffalo program in the tropical area of Cochabamba. In 1981 the author received a Master's degree in Animal Science from the University of Florida. Following graduation, he joined the Bolivian Research Institute and has been working on native cattle and forage programs in the tropical area of Bolivia.

In January 1987, the author enrolled in the Graduate School at the University of Florida. At the present he is candidate for the degree of Doctor of Philosophy.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

L.R. McDowell, Chairman
Professor of Animal Science

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

J.H. Conrad
Professor of Animal Science

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

C.B Ammerman
Professor of Animal Science

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

C.R. Staples
Associate Professor of Animal Science

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

O.C. Ruelke
Professor of Agronomy

This dissertation was submitted to the Graduate Faculty of the College of Agriculture and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

August, 1990

Jack L. Fry

Dean, College of Agriculture

Dean, Graduate School